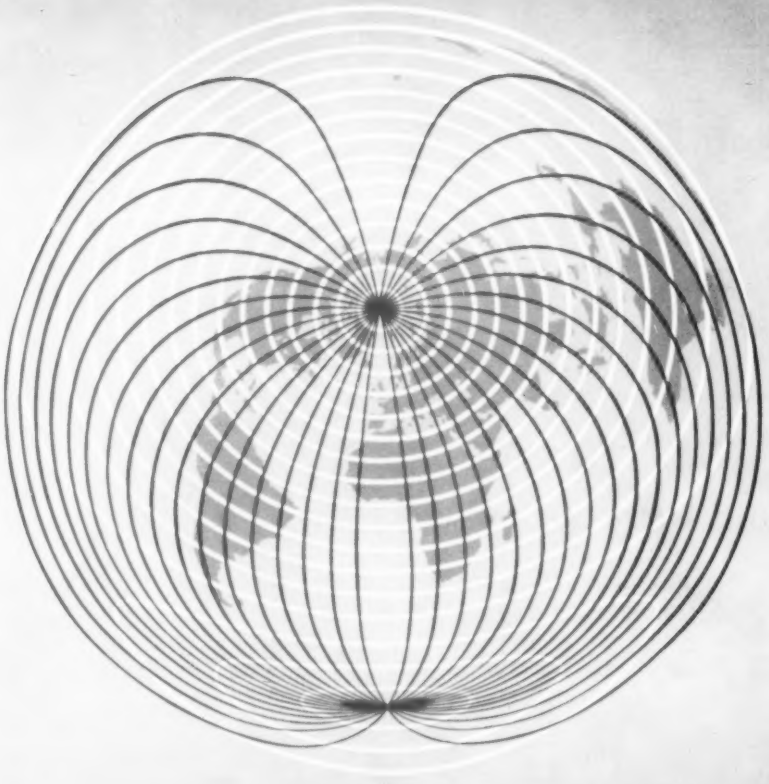
Wireless World

SEPTEMBER 1952 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

A new low-priced

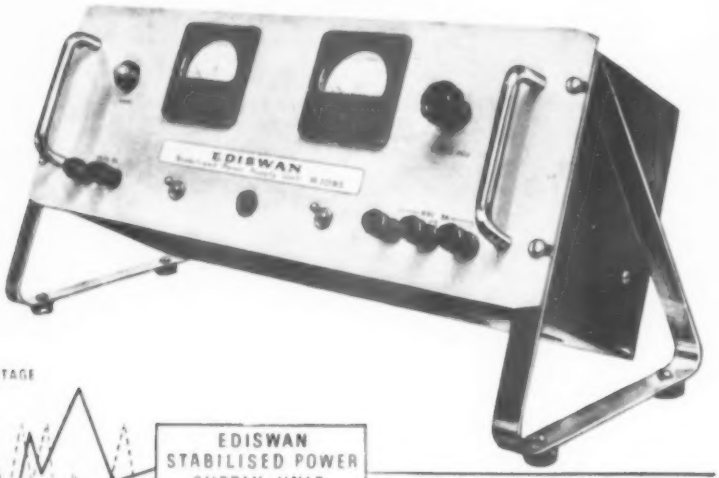
STABILIZED POWER SUPPLY UNIT

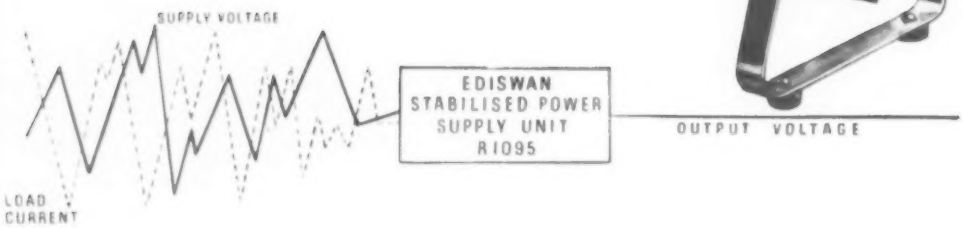
PRICE

Stabilized Power Supply Unit (metered) £23.2.6

Stabilized Power Supply Unit (without meters) £18.18.6

Plated Bench Stands £1.1.0





Designed and developed as a result of many years experience in the design and use of Stabilized Power Supplies for research and test purposes, the Ediswan Stabilized Power Supply Unit R.1095 is an entirely new, low-priced constant voltage source.

Operating on 200-250 volts, 40-100 cycles A.C. supply it provides an adjustable 120-250 volts D.C. highly stabilized supply at 0-50 mA and a 6.3v C.T. 3 amp. A.C. unstabilized output for heater supply.

The stability is such that with mains change of 10v, output change is less than 0.1v. With load change of 0-50 mA, output change is less than 0.1v.

Output resistance less than 2 ohms. Ripple approximately 2 mV.

The unit can be supplied with or without meters. Provision is made for the addition of meters at a later date. The unit is designed for standard 19" rack mounting or for bench use. Plated bench stands as illustrated are available if required.

Further details are available on request.

EDISWAN

THE EDISON SWAN ELECTRIC COMPANY, LTD.

Radio Division

155 CHARING CROSS ROAD, LONDON, W.C.2.

Member of the A.E.I. Group of Companies

Telephone: Gerrard 8660. *Telegrams: Ediswan, Westcent, London.*

UP70

Model 8 UNIVERSAL AVOMETER

20,000 ohms per volt *plus* AUTOMATIC Overload Protection

Produced in response to a demand for a high sensitivity version of the world-famous Universal AvoMeter, this model incorporates the traditional design features of its predecessors, so highly valued for simplicity of operation and compact portability.

It has a sensitivity of 20,000 ohms per volt on all D.C. voltage ranges and 1,000 ohms per volt on A.C. ranges from 100V. upwards. A decibel scale is provided for audio frequency tests. In addition, a press button has been incorporated which reverses the direction of current through the moving coil, and thus obviates the inconvenience of changing over test leads when the current direction reverses. It also simplifies the testing of potentials, both positive and negative, about a common reference point. A wide range of resistance measurements can be made using internal batteries, separate zero adjustment being provided for each range.

It is of importance to note that this model incorporates the "AVO" automatic cut-out for protection against inadvertent overloads.

£23 . 10s.

Size 8¼" x 7½" x 4½"
Weight 6½lbs. (including leads)

WE SHALL BE AT THE **RADIO SHOW** EARLS COURT AUG 27 - SEPT 6

Stand **46**

For your Valve Characteristic Meter or Valve Tester

Owing to the very large number of valves which have been issued within the last two years, no further amendments will be issued for the original "Avo" Valve Testing Manual. A new, completely revised and fully up-to-date Valve Data Manual is now available from the Company at 15/- post free.

D.C. VOLTAGE	D.C. CURRENT	A.C. VOLTAGE	A.C. CURRENT	RESISTANCE
2.5V.	50μA.	2.5V	100mA.	*First indication 0.5Ω.*
10V.	250μA.	10V.	1A.	*Maximum indication 20MΩ.*
25V.	1mA.	25V.	2.5A.	0—2,000Ω { using internal batteries.
100V.	10mA.	100V	10A.	0—200,000Ω { using internal batteries.
250V.	100mA.	250V.	—	0—20MΩ { using internal batteries.
1,000V	1A.	1,000V.	—	
2,500V.	10A.	2,500V.	—	0—200MΩ { using external batteries.

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
WINDER HOUSE • DOUGLAS STREET • LONDON S.W.1 *Telephone* VICtoria 3404—9

AB/1
A

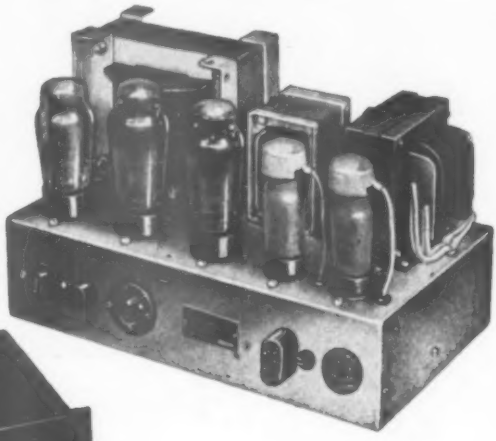
GOODSELL

HIGH FIDELITY SOUND EQUIPMENT

Type MA15 Amplifier £19 10 0

U/TC Wide Range Tone Control £8 15 0

F/U/TC as above with sharp cut off filter £12 12 0



Type MA15 Amplifier is the latest addition to our range and our wide experience of quality reproduction has been used to produce this highly developed unit. The output transformer is of special design having all the characteristics which are necessary in amplifiers having high overall feedback and a wide margin of stability.

NOTE THESE FEATURES:—

- Less than 0.1% distortion and minus 80dB noise level at 12 watts output.
- Sturdy design for trouble-free life including adequately rated transformers, paper reservoir condenser and best quality components.
- Clean layout with tagboard sub-assembly.
- Power output of 12 watts from 1.5 volt input using two EL37 pentodes, triode connected, in the output stage.
- Overall feedback greater than 20dB.
- Finish—the steel chassis is heavily primed and stove enamelled polychromatic grey.
- Can be supplied tropicalised and completely enclosed in top steel cover if required, at small extra cost.

The Type U TC Wide Range Tone Control also represents the latest design and has been arranged to accept inputs from either crystal or low output magnetic pickups including the moving coil and radio.

Type F/U/TC is similar to the above, but includes a steep cut filter operating at selected frequencies. This type of filter has proved itself superior to any other form of low pass arrangement as the response may be maintained fully up to the point at which it is desired to cut.

These types of unit use feedback in every stage thus both are complementary to either the new MA15 or the standard Williamson amplifier, because of their low distortion characteristics and effective operation.

Full details of above, tuners and Williamson amplifiers available from:—

GOODSELL LTD., 40 GARDNER STREET, BRIGHTON, 1

AMERICAN (R.T.M.A.) TYPES REPLACEABLE BY MULLARD VALVES

R.T.M.A. NUMBER	MULLARD REPLACEMENT
0A4G	1267
0E3	B5A1
1A3	DA90
1AC6	DK92
1L4	DF92
1R5	DK91
1S5	DAF91
1T4	DF91
2D21	2D21
3A4	DL93
3A5	DCC90
3B28	3B28
3NP4	MW6-2
3S4	DL92
3V4	DL94
4B32	4B32
5V4G	GZ32
5Z4G	GZ32
6AB8	ECL80
6AK5	EF95
6AL5	EB91
6AM5	EL91
6AM6	EF91
6BE7	EQ80
6BX6	EF80
6CI6	EL81
6J6	ECC91
6N8	EBF80
6X2	EY51
12AT7	ECC81
15A6	PL83
16A5	PL82
FG17	MT17
17Z3	PY81
19X3	PY80
19Y3	PY82
21A6	PL81
FG57	MT57
FG105	MT105
807	QV05-25

R.T.M.A. NUMBER	MULLARD REPLACEMENT
829B	QQV07-40
866A	RG3-250A
1267	1267
5544	MT5544
5545	MT5545
5557	MT17
5559	MT57
5861	ME1001
5866	TY2-125
5867	TY3-250
5868	TY4-500
5894	QQV06-40
5895	QQZ04-15
6155	QY3-125
6156	QY4-250

NEAR REPLACEMENTS

R.T.M.A. NUMBER	MULLARD REPLACEMENT
2J42	ME1101
4D21/4-125A	QY3-125
5CP1-A	DG13-2
5CP7-A	DP13-2
5D22/4-250A	QY4-250
5FP4-A	MW13-35
6J7GT	EF37A
6L6G	EL37
6SL7GT	ECC35
6SN7GT	ECC33
6X5G	EZ35
CK512AX	DF66
CK523AX	DL66
723A/B	ME1100
5800/VX41	ME1402
5802/VX32	ME1401

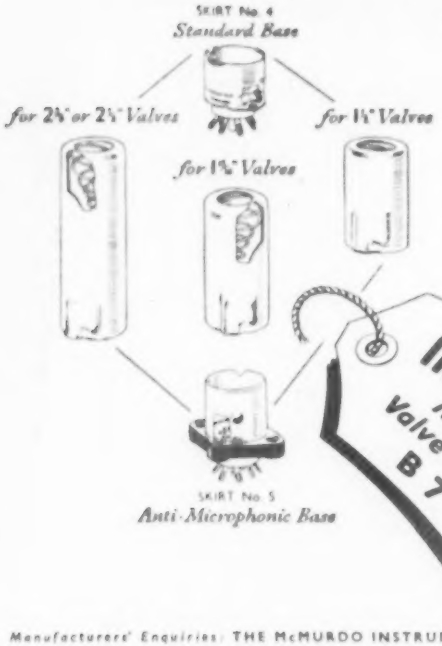
Mullard

Mullard

This is a page from the new edition of "Valves and Tubes for Industry and Communications."
WRITE FOR COPY TO ADDRESS BELOW

MULLARD LTD., COMMUNICATIONS AND INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT123



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ASHTEAD 3401

FERROXCUBE

FERROMAGNETIC FERRITE

FOR TELEVISION

THE improvement in television components, with their smaller size and greater efficiency, is largely due to Ferroxcube, the new Mullard magnetic core material.
The uses of Mullard Ferroxcube in the production of TV components fall into these three main groups:

LINE OUTPUT TRANSFORMER CORES

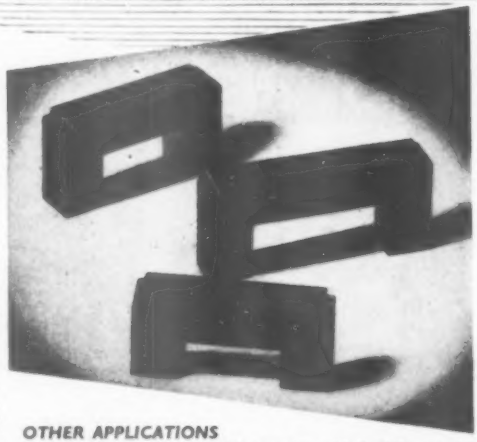
Since the advent of wide-angle television tubes, with the accompanying demand for increased E.H.T. supplies, the need for line output transformers of the highest possible efficiency has been greater than ever. Mullard Ferroxcube, with its low iron losses, completely fulfils this need — also facilitating the assembly of small, compact transformer units by means of solid, non-laminated U-shape cores.

DEFLECTION COIL YOKES

Mullard Ferroxcube cores in ring form are ideal for producing the magnetic circuit around deflection coils. Used in this way, Mullard Ferroxcube makes possible the construction of efficient deflector coils with a high Q factor. In order to simplify assembly problems, these ring cores are supplied either in the form of a complete circle, as two semi-circles, or as castellated yokes.

LINEARITY AND PICTURE WIDTH CONTROLS

Mullard Ferroxcube can very conveniently be extruded into rods and tubes. In this form it is ideal for use in linearity and picture width controls, providing a smooth control in a compact assembly.



OTHER APPLICATIONS

In addition to its uses in television receivers, Mullard Ferroxcube is also being widely employed in line communications, radar, and other specialised electronic equipments. The purposes for which it is already being most successfully applied in such equipments include filter networks, wide band transformers, magnetic amplifiers, and pulse transformers.

PLEASE WRITE FOR FULL DETAILS

Mullard **FERROXCUBE**

FERROMAGNETIC FERRITE

MULLARD LIMITED CENTURY HOUSE SHAFTESBURY AVENUE LONDON W.C.2.
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for VHF *applications*

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Disc units are supplied in values up to .01 MFD. Ceramic insulated tubulars up to 6000 PF. GP (phenolic insulated) and non-insulated Ceramicons* up to 18600 PF. Stand-Off and Feed-Thru units up to 10000 PF. Trimmers: 531 from 0.5 to 5 PF. and from 1 to 8 PF. Trimmers: 557 from 5 to 30 PF.

Write for complete information to meet your specific requirements.

ERIE* Resistor Ltd

* Registered Trade Marks

CARLISLE ROAD, THE HYDE, LONDON, N.W.9. Tel: COLindale 8011. *Factories: London and Great Yarmouth; Toronto, Canada; Erie, Pa., U.S.A.*

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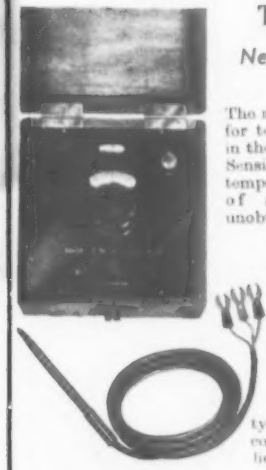
A high-grade, 3½" scale moving coil instrument, robust, accurate and speedy in response. Normally supplied with 2 scales, 0-200°C and 0-400°C, and suitable couples. Also supplied with ranges up to 1,000°C for all standard thermo-couples.

Thermo-couples are supplied with 4ft. compensating leads.
£3 8s. each

Price £8 15s.



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New Low Temperature Indicator

The most versatile instrument for temperature measurement in the range −80°C to +200°C. Sensitive to rapid changes of temperature, to a high degree of accuracy hitherto unobtainable in any other form of temperature indicator. Sections of 20 degrees or more between maximum and minimum of instrument range can be spread over the 8" scale. Self-contained dry battery. Unaffected by voltage change or length of leads (which can be as long as required). Pencil type detector for surface contact, immersion, air or liquids.

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Imagine! One sturdy HANDY-UTILITY power tool, a selection of HANDY-UTILITY accessories and attachments, and you're ready for anything —sanding, grinding, wire brushing . . . buffing, waxing, polishing . . . and the same magnificent tool can be used as an electric drill, with ¼" capacity in steel! There are two robust Stands to increase the usefulness of your 5" Sander-Polisher still further. Full particulars from your HANDY-UTILITY dealer.

Other HANDY-UTILITY tools include:—
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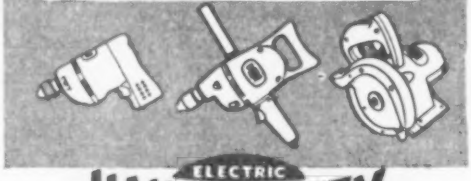
6" HEAVY DUTY 'LECTRO-SAW' £17·5·0
and a wide range of useful accessories



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PRODUCTS OF THE M.U. DIVISION OF BLACK & DECKER LTD.

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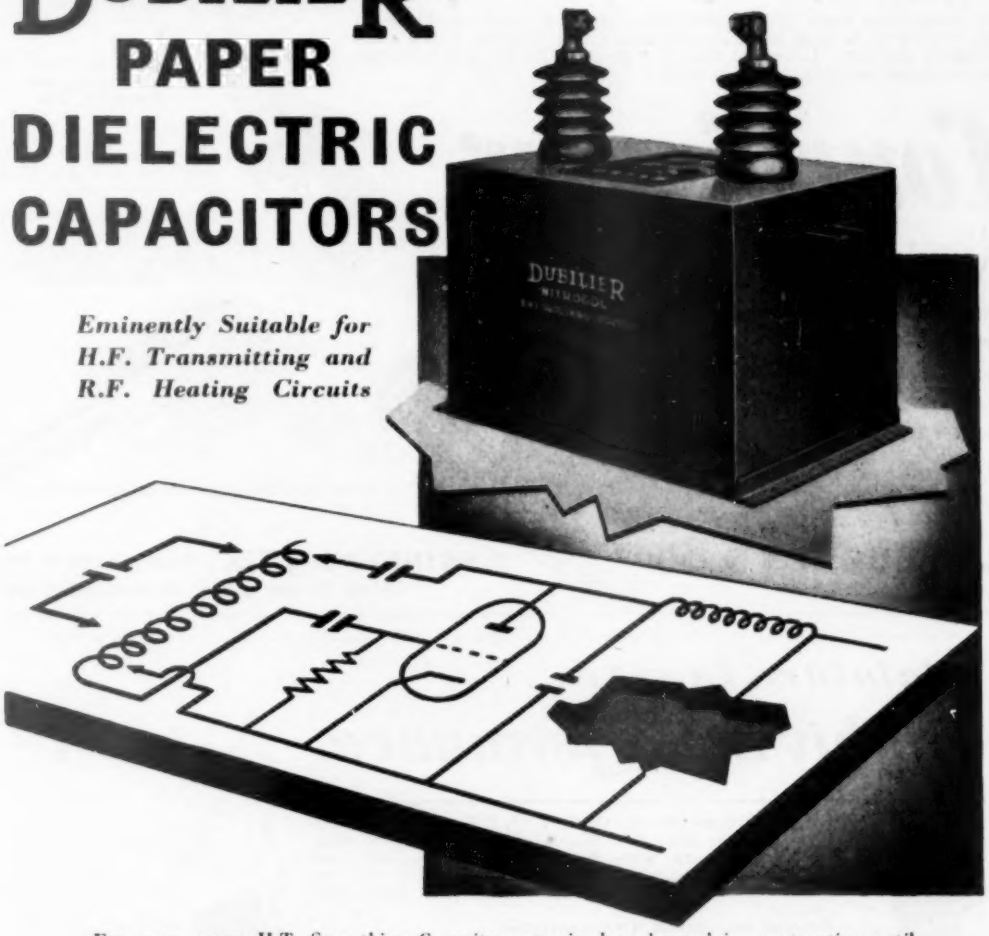
Simm's H.U.40

DUBILIER PAPER DIELECTRIC CAPACITORS

Eminently Suitable for H.F. Transmitting and R.F. Heating Circuits



For many years H.T. Smoothing Capacitors remained unchanged in construction until Dubilier introduced to this country the modern compact form which greatly reduced the amount of inactive material employed.

The illustration depicts a typical example, representative of current practice. The design and manufacture is based upon the famous Nitrogol technique combining the superior performance at elevated temperature of high viscosity mineral jellies, with the advantages of the best mineral oils.

This capacitor is designed for use in all D.C. and/or low frequency A.C. applications. Details of this and other outstanding capacitors are available on application.

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D75

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The Connoisseur Super Lightweight pick-up has three interchangeable heads each fitted with an easily replaceable armature system complete with a semi-permanent sapphire. Downward pressure 8-10 grams for standard recordings and 4-6 grams for microgroove recordings.

Pick-up with one head £4/10/-, plus £1/19/- P. Tax.

Extra heads each £2/10/- plus £1/1/8 P. Tax.

Spare Armature System with sapphire 10/3 plus 4/5 P. Tax.

Green spot with .001in. radius sapphire for Microgroove recordings.

Red spot with .0025in. for modern standard.

Yellow spot with .003in. for older standard.

Connoisseur

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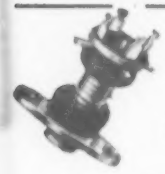
miniature in size...
mighty in performance



Little wonder that OSMOR "Q" RANGE COILS are the "big noise"... No imitations, regardless of price, can compare with them for super selectivity and sensitivity. And you don't just have to take our word for it—the watertight guarantee makes your satisfaction certain!
Consider these points of superiority :—

★ **Only 1in. high.**
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COILPACKS. A full range is available for Superhet and T.R.F. Mains or Battery. Size only 1⅞in. high × 3¼in. wide × 2¼in. Ideal for the reliable construction of new sets, also for conversion of the 21 RECEIVER, TR 1196, TYPE 18, WAR-TIME UTILITY and others.

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Send 5d. (stamps) for **FREE CIRCUITS** *and full list of coils, coilpacks and radio components.*

Aligned and tested, with full circuits, etc. Fully descriptive leaflets available.

***WARNING!** Avoid inferior imitations. Genuine OSMOR Coilpacks are sold only under the name OSMOR.*

OSMOR *radio products ltd*

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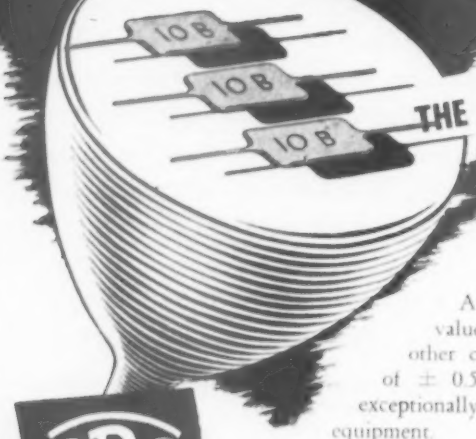
Designed for the finest Television



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DIMENSIONS	7 × 15 mm
CAPACITANCE RANGE	2 pF—50 pF
CLOSEST TOLERANCE	± 0·5 pF

A space saving silvered mica capacitor for the "low" value range. Widely used in television receivers and other compact electronic assemblies. A close tolerance of ± 0.5pF can be supplied economically. Stability is exceptionally high. Specify our type 10B for your miniature equipment.

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The new "LINCOLN" Amplifier is a high fidelity unit with push-pull output—a novel arrangement permits connection of the output valves EITHER AS TRIODES OR TETRODES—outputs of 3 and 10 watts being obtainable respectively.

TREBLE AND BASS LIFT AND CUT. Sensitivity for full output of 100 m/volts, with 12 dbs. of feedback on both triode and tetrode connection.

The circuit employs four valves (including a double triode) and full wave rectifier.

Power supplies: 200-250 v. 40-60 c/s A.C. at 60 watts.

PRICE (as illustrated), with coaxial plug, **£18/18/-**

LATEST "LINCOLN" RELEASES

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1. Three band—Long, medium and short.
2. Large illuminated dial.
3. Three position variable selectivity.
4. Full Automatic volume control.
5. Three valves, 12AH8, 6BA6, 6AT6.
6. Gramophone pre-amplifier with automatic correction for Decca and E.M.I., 33s, 45s and 78s.
7. Plugs directly into the LINCOLN amplifier and suitable for most other types of quality amplifiers.

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Completely enclosed in "Neosid" former, ensuring minimum external field. Unusually good waveform with maximum amplitude at 45 Kc/s. Lettered tag panel connections and one-hole fixing.

Overall size, 1⅛in. x 1⅛in. x 1in. PRICE 12/6. (Post 6d.)

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SELECTIVE TRANSMISSION MEASURING SET

B.C.C. introduce another outstanding success in their development of Measuring Instruments.

This instrument is a direct reading, selective, gain and loss measuring set to be used with an external signal generator.

Four terminal networks, active and passive, balanced or unbalanced, can be measured.

Facilities are provided for use as a high impedance Selective Detector Amplifier.

Frequency Coverage : 1—68 Kc/s in 4 ranges.

Range of Measurements : Gain 0-60 db. Loss 0-80 db.

Accuracy : ± 0.5 db.

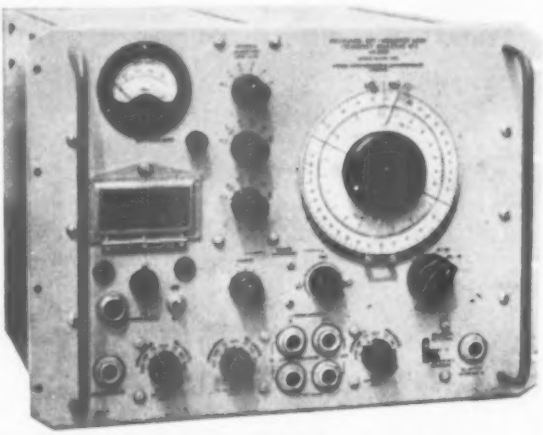
Impedance range : 75, 150 and 600 ohms.. balanced or unbalanced.

Det.-Amp. Sensitivity : 10-12 μV.

Power Supplies : 100-150-200-250v. 50 c/s.

Based on Signals Research and Development Establishment design.

Manufactured for Ministry of Supply and G.P.O.



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★ ***The safeguard for all receivers.*** The new **Aerialite** Neon LIGHTNING ARRESTOR 8/6

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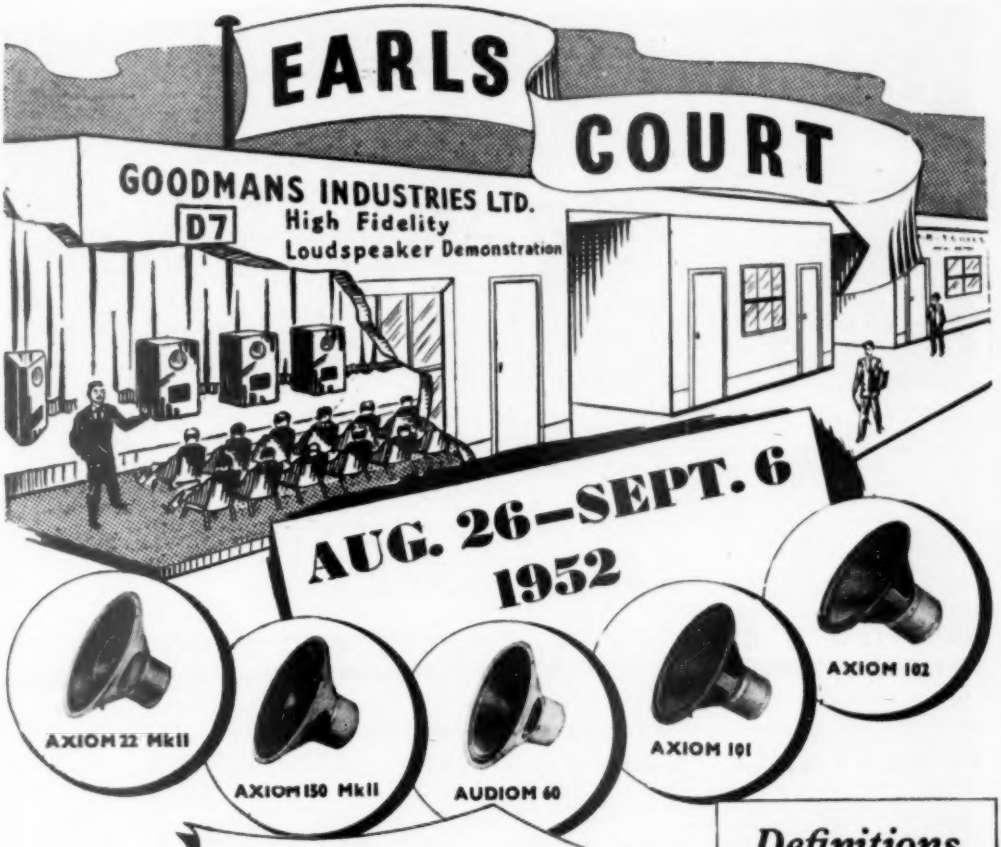

A Practical Test

A cold advertisement with its printed claims is all very well as an introduction to a product, but how much better a practical test of a manufactured characteristic.

Over 3,000 people passed through our demonstration room at the recent Northern Radio Show held in Manchester. At the end of each demonstration period we received a round of spontaneous applause denoting the obvious pleasure that good quality reproduction can afford to the receptive ear.

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At this year's 'Radio Earls Court' we of the House of Goodmans once again have the pleasure of presenting for your enjoyment a practical demonstration of our High Fidelity Reproducers.

The reproducers demonstrated will include the well-known Axiom series in modified form and, of recent design, two special high fidelity 8" units—Axiom 101 and 102.

We look forward to the pleasure of your company. Remember—Demonstration Room No. D.7 and Stand 41, Earls Court, August 26 to September 6, 1952.

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COMMUNICATION RECEIVER

30 Mc/s to 480 Kc/s

USED PROFESSIONALLY IN ALL PARTS OF THE GLOBE

Compare critically the Eddystone "680X" against world-wide production of similar equipment and you will find nothing to equal either the performance or the construction of this receiver at anywhere near its price level.

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The "680X" has a first-class electrical specification. Fifteen valves are used; two RF and two IF stages, separate oscillator and push-pull output. Figures for sensitivity, noise, selectivity and image ratio are excellent. Frequency drift is negligible on all ranges.

The "680X" receiver is handsomely finished in polychromatic grey and has an all-round performance of the highest order.

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STRATTON & CO. LTD., EDDYSTONE WORKS, BIRMINGHAM 31

INDUSTRIAL ELECTRONICS *miniature*

Model 1200B

price **£33.12.0**

D. C. OSCILLOSCOPE

A high performance instrument of small size and light weight. Reliability and low cost, with D.C. coupled 'X' and 'Y' amplifiers of high sensitivity and wide frequency response make it suitable for laboratory or field use.

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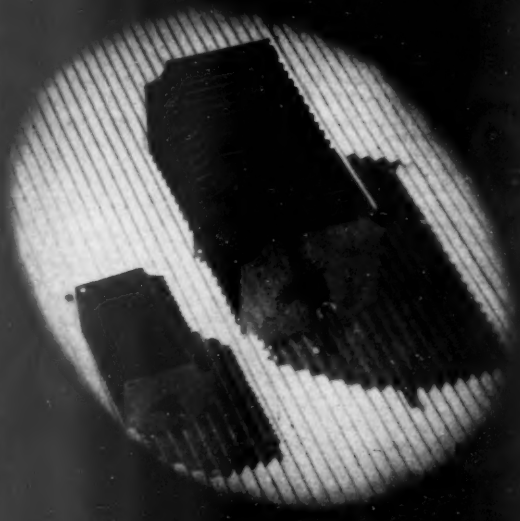
G.E.C. SELENIUM RECTIFIERS



G.E.C. Selenium Rectifiers are ideal for all applications where a D.C. power supply is to be provided from an A.C. source. They are designed and rated for long life and reliable operation, have high operating efficiency and are economical in first cost. A comprehensive range is available for output currents from a few milli-amps. to thousands of amps.

Full particulars available on application to:—

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THE Soundmirror

MAGNETIC TAPE RECORDER

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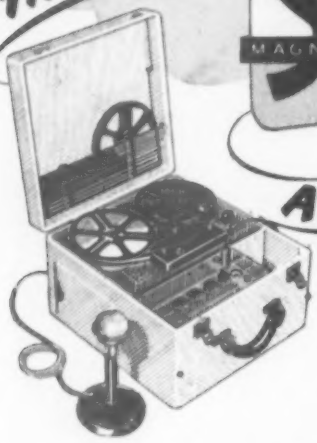

A self-contained recorder/reproducer giving a faultless performance. The ideal equipment for HOME ENTERTAINMENT, PUBLIC ADDRESS, CONFERENCE RECORDING, and SOUND COMMENTARY for SILENT FILM PROJECTORS.

- "Finger Tip" operation—one control provides for "Record"—"Play" "Rewind" or "Fast Forward" requirements.
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Now available in England—the book "Magnetic Recording" by Dr. S. J. Begun. A comprehensive treatise. Price 25/-, postage 9d. extra.

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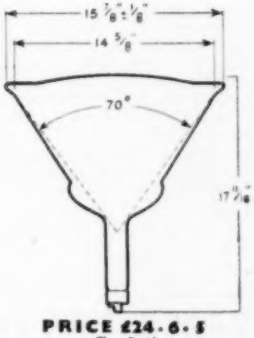
Conventional assembly methods and parts are used for the electron gun of the 'ENGLISH ELECTRIC' C.R. Tube T.901, but there is one feature that deserves to be noted. This is the Ion Trap, fitted to prevent ion spot or "burn" which could otherwise spoil the picture. The electron gun of the T.901 is so made that negative ions are removed from the electron beam and cannot therefore reach the tube screen and cause "spotting." *Blemish or "burn" will not occur with the 'ENGLISH ELECTRIC' T.901 tube under normal working conditions.*



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HIGH STABILITY, close tolerances from 1% ¼, ½, 1 and 2 watts. All values up to 2 meg., including 8, 13 and 30 meg.

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D.C. Resistance 47 ohms. Impedance: 88 ohms at 1,000 c.s.

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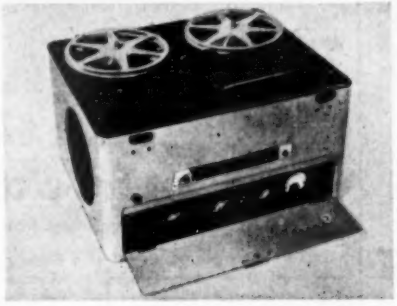
To those who are waiting...

TO THOSE who have waited long and patiently for their Ferrographs we tender our apologies. We do feel, however, without appearing unduly immodest, they will agree the waiting has been worth while.

The Ferrograph is still not easy to obtain —firstly because the special materials going into its construction are restricted, and secondly the Ferrograph has appeared in Service Dress and is now in quite large-scale production for Defence purposes.

Nevertheless it is our practice, whenever circumstances permit, to supply instrument-type Ferrographs for the special needs of Industry, Education, Science and Research. Among the many types of specialised recorder instruments now in the Ferrograph range is Type "YD"—of which an abridged specification appears on right.



★ **"FERROTAPE" NOW FREELY AVAILABLE**
1,200 feet £2.5.0: 600 feet £1.6.0: 200 feet 12/6d.—all on anodised aluminium reels with patent "Hublok" centre.

FERROGRAPH TYPE "YD"

SUPPLY VOLTAGES
100-120 volts and 200-250 volts A.C. 50 c.p.s. (60 c.p.s. by special pulley).

RECORDING MEDIUM
WW372/49 Ferrotape on reels of 1200 ft., coating inside.

TAPE SPEEDS
7½", 3¾", and 1⅞" per sec.

TRACK WIDTH
0.1" displaced to one edge.

NUMBER OF TRACKS
2 side by side.

RUNNING TIME (50 c.p.s. supply)
30 mins. each track at 7½" p.s. total 1 hour per reel, pro rata for other speeds.

REWIND TIME (and wind-on)
Less than 1 min. for full reel.

FREQUENCY RESPONSE (WW372/49 Ferrotape)
(a) At 7½" p.s. 70—10,000 cycles ± 3 db.
(b) At 3¾" p.s. 70—4,000 cycles.
(c) At 1⅞" p.s. 70—2,000 cycles.

INPUT IMPEDANCES AND LEVELS
(a) *Line Input.* — 600 ohms. Balanced.
(b) *Microphone Input.* —1 megohm unbalanced, or using external plug in matching transformer, 25 ohms. Balanced.

OUTPUT IMPEDANCES AND LEVELS
(a) *Main Output* — 600 ohms. Balanced.
(b) *Monitor Loudspeaker* — 1 watt to internal 5" speaker.

SIGNAL TO NOISE RATIO
(a) In the range 200-10,000 cycles, for 1 watt main output 50 db approximately.
(b) Unweighted signal to noise, better than 40 db.

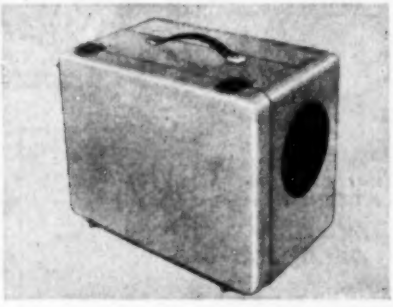
DISTORTION
At 1 watt output, 400 c.p.s. for Ferrotape, less than 5% total.

"WOW" AND FLUTTER (Expressed as change in tape velocity)
Less than 0.2% at 7½" p.s.

POWER CONSUMPTION: 110 watts.

FINISH
Light Battleship grey, British Standard Colour 631.

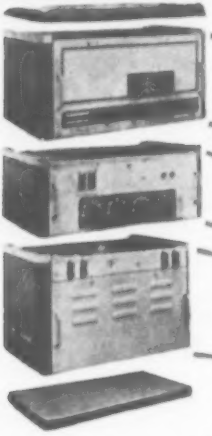
WEIGHT OF UNIT: 56 lbs.



British Ferrograph Recorder Co. Ltd.

138 SLOANE ST., S.W.1 · SLO. 1510

MAGNETA SECTIONAL AMPLIFIER ASSEMBLIES



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A 2	74	1.3	0.26	0.44	
A34	73	0.6	1.5	0.88	HIGH POWER FLEXIBLE
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C 1	7.3	180	2.5	0.36	
PC1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	3.4	197	1.8	0.64	
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A newly designed A.C. mains operated R.F. Signal Generator of improved performance and reliability. Wide range and accuracy make it an ideal instrument for modern Radio and Television work.

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100–320 Kc/s.	3.2–10 Mc/s.
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Frequency calibration accuracy is within ± 1 per cent.

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A comprehensive mutual conductance valve tester, suitable for most types of British, American and Continental receiving valves. Supplied with valve chart giving data for testing nearly 3,000 different valves. For use on A.C. mains only.

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FS2. 250-0-250 v. 80 m.a. 23/-
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FS43X. Output, 425-0-425 v. 250 m.a., 6.3 v. 6 amps., 6.3 v. 6 amps., 5 v. 3 amps. Fully shrouded. 69/-
MS6. Output, 250-0-250 v. 100 m.a., 6.3 v. 6 amps., C.T. 5 v. 3 amps. For receiver R1355. Half shrouded. 29/3
MS150. Output. 350-0-350 v. 150 m.a., 6.3 v. 3 amps., C.T. 5 v. 3 amps. Half shrouded. 30/9
FS6. Output. 250-0-250 v. 100 m/a., 6.3 v. 6 amps., C.T. 5 v. 3 amps. Fully shrouded. 32/6
PS120. Output. 350-0-350 v. 120 m/a., 6.3 v. 2 amps., C.T. 6.3 v. 2 amps., C.T. 5 v. 3 amps. Fully shrouded. 33/-
FS256. Output. 250-0-250 v. 80 m.a., 6.3 v. at 6 amps., 5 v. at 3 amps. Fully shrouded. 30/9
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FS150. 350-0-350 v. 150 m.a., 6.3 v. 4 amps., 5 v. 3 amps. 34/9
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The above have inputs of 200/250 v.

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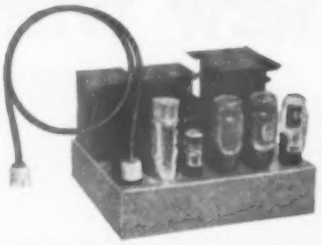

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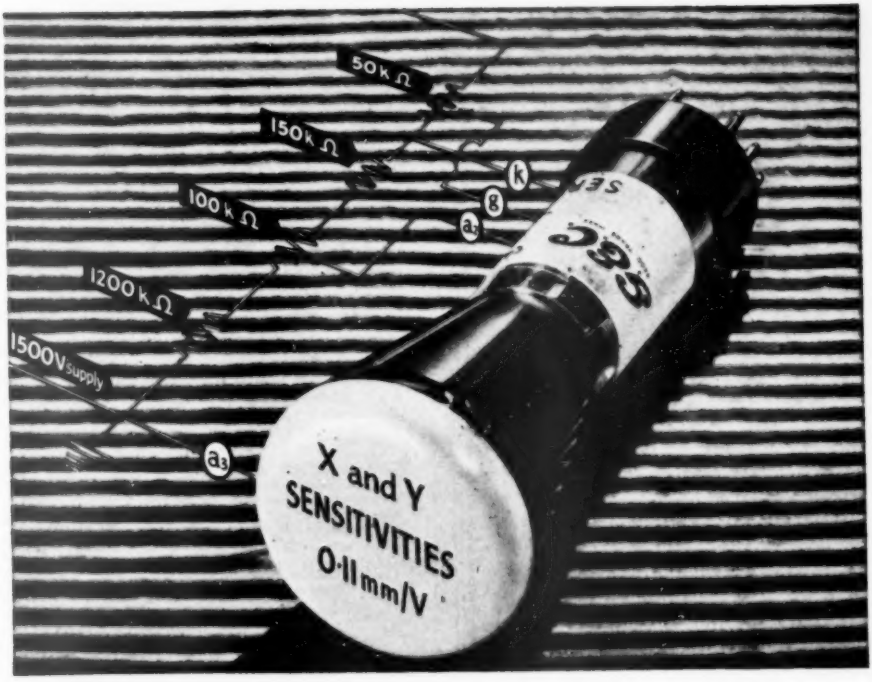

G.E.C. instrument cathode ray tubes

The above illustration shows a typical supply network suitable for the E4205-B-7; the deflection sensitivity increases as Va3 is reduced until it is 0.28 mm/V at the minimum of 600V. G.E.C. electrostatic instrument tubes are available in four standard sizes. All have 4V heaters and short-persistence green screens. Brief details are given in the table—for further information apply to the Osram Valve and Electronics Department.

Type No.	Bulb dia. (mm)	V_{a3}	Sensitivity (mm/V)		Base
			X	Y	
E4103-B-4	39	600-1000	$\frac{90}{V_{a3}}$	$\frac{100}{V_{a3}}$	Brit. 9-pin
E4205-B-7	70	600-1500	$\frac{170}{V_{a3}}$	$\frac{170}{V_{a3}}$	B12B
E4412-B-9	90	600-4000	$\frac{350}{V_{a3}}$	$\frac{750}{V_{a3}}$	B12D
E4504-B-16	160	600-5000	$\frac{600}{V_{a3}}$	$\frac{1100}{V_{a3}}$	B12D

Special screens are available to order.

A range of specialised tubes is available for applications where normal types are unsuitable. Detailed information is available upon receipt of requirements.

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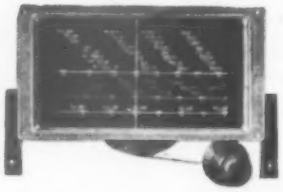

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PRICE 27/6.

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PRICE 26/6.

Replacement Scales calibrated to Copenhagen Plan now available for :

Airplane drive	2/3 retail	Full Vision Drive	2/9 retail
Squareplane Drive	2/6 retail	S.L.8 or S.L.5 Drive	4/6 retail

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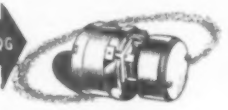
R.Q.R. GEARED for continuous or intermittent running or reversing at speeds from 27 mins per rev. to 600 revs. per min., with or without self-switching up to 2½ r.p.m.

RQG



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RQR

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RQ11

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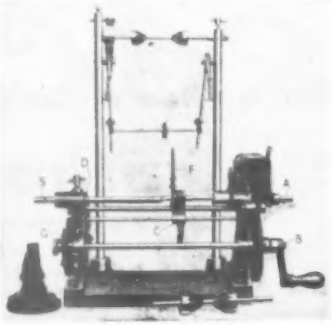

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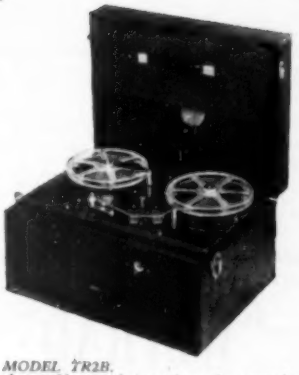

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3-Speaker System

W15 CS W10 CS Super 5

Treble units facing upwards.

Crossover frequencies 800 & 5,000 c/s.

Results from a 2-speaker system are usually improved by the addition of a third speaker. A crossover between 500 and 1,000 c/s is satisfactory with a 10in. or 8in. unit for the middle and upper registers plus a 5in. unit to improve the extreme "top." The 5in. speaker is connected in parallel with the middle speaker, with a capacitor of .5 or 1 mfd. in series with the voice coil of the small unit.

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Acoustically it is difficult to choose between quarter section and half section filters. The half section is probably to be preferred as, with some amplifiers, it reduces the risk of instability through the feedback circuit. In either case, a 16 ohm treble speaker is quite satisfactory with a 15 ohm bass unit. The addition of the third speaker with series capacitor does not upset the main crossover network in any way.

ADAPTABILITY

Existing two-speaker systems are easily adapted to three-speaker working without waste. Where a crossover at 2/3,000 c/s is already in use, it is important to double the values of inductance and capacitance to lower the crossover frequency when changing to a three-speaker set-up.

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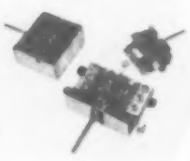

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Vg (cut-off)	−50 *V*
Va1	1200 *V*
Va2 (focus)	800/850 *V*
Va3 (wall)	1200 *V*
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Speeds Continuously variable from 3in. to 8in. per second. Set by meter. Standard speeds of 7½in. and 3¾in. specially marked. Twin track recording giving one hour at 7½in. or two hours at 3¾in. per sec.

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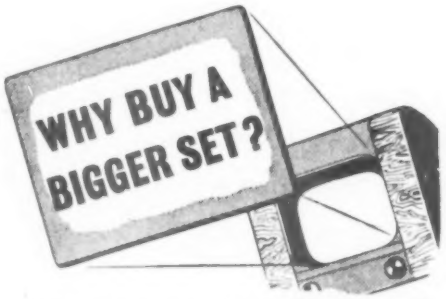

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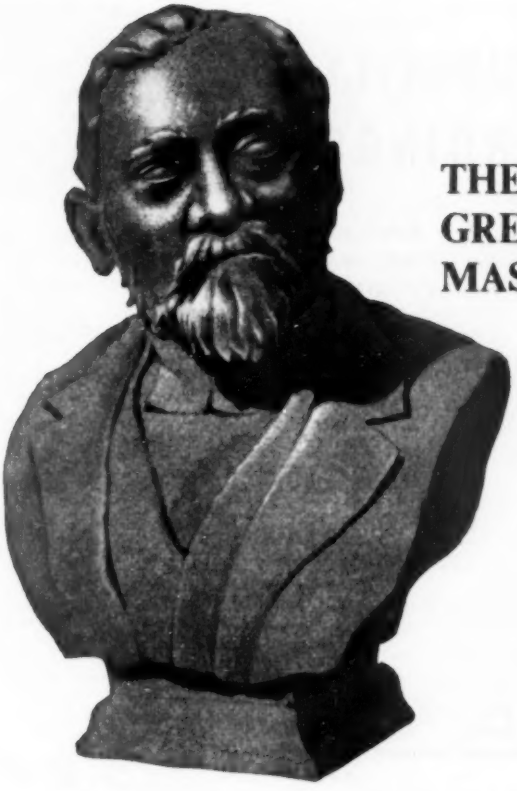

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50 c/s to 10 Kc/s at a playing speed of 7½ in./sec.

Medium coercivity gives a high signal output with an extended high-frequency response, whilst still retaining an easy erasure. Signal/noise ratio is high; transfer and distortion are negligible.

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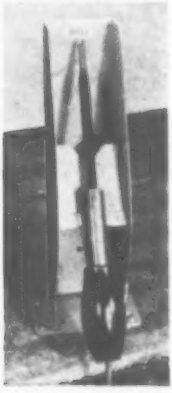

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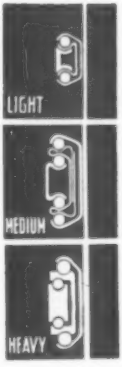

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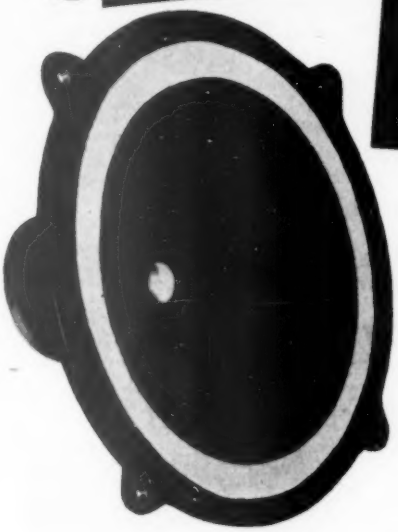

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Fundamental resonance	(approx.) 35 c.p.s.
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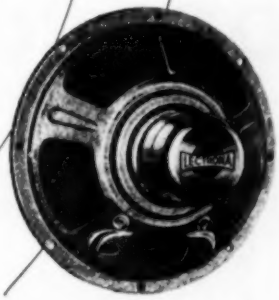

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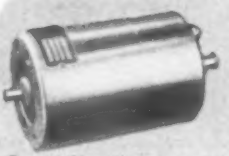

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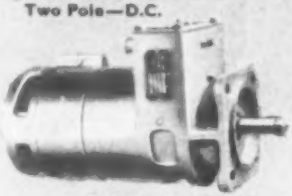

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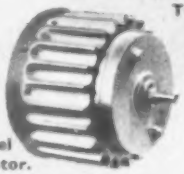

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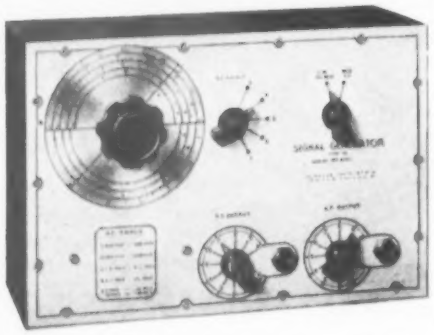

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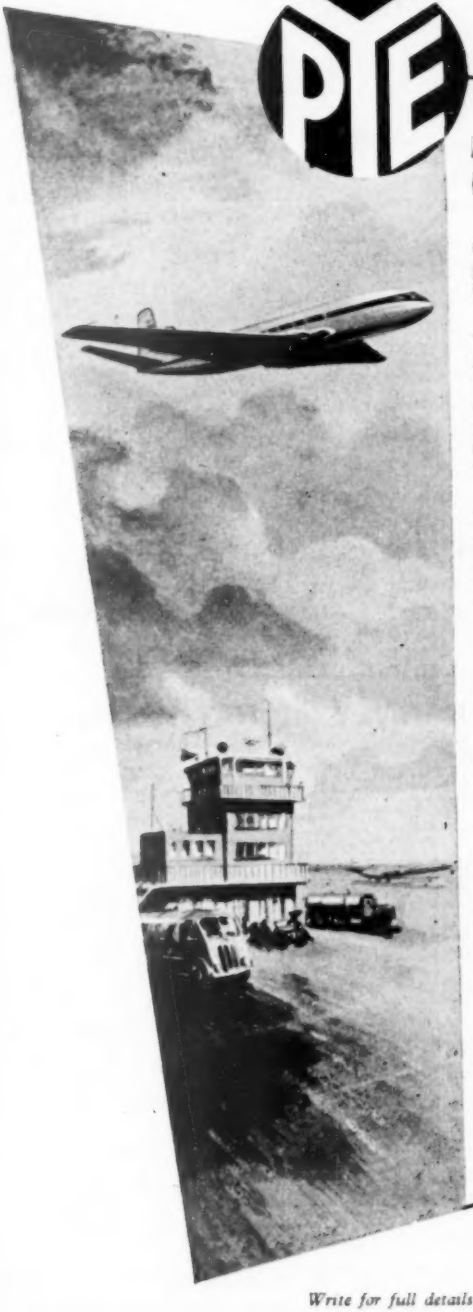

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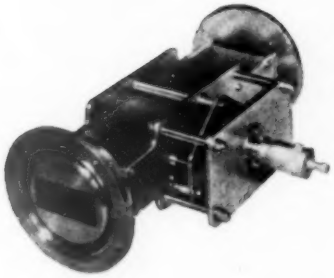

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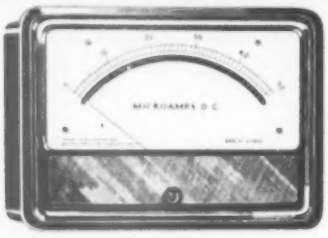

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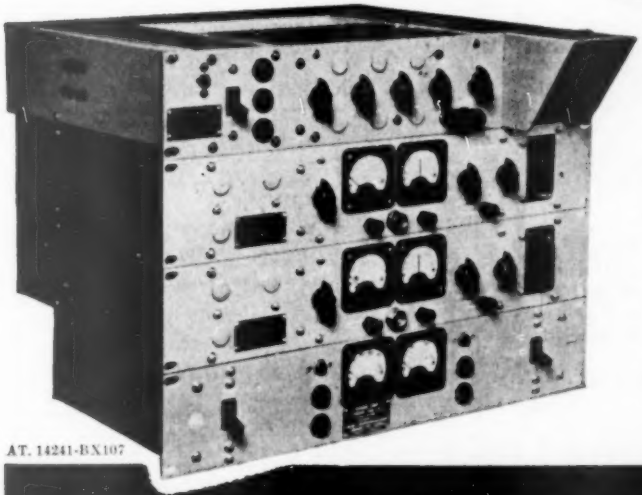

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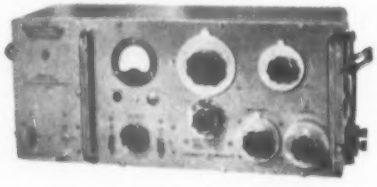

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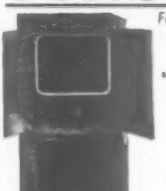

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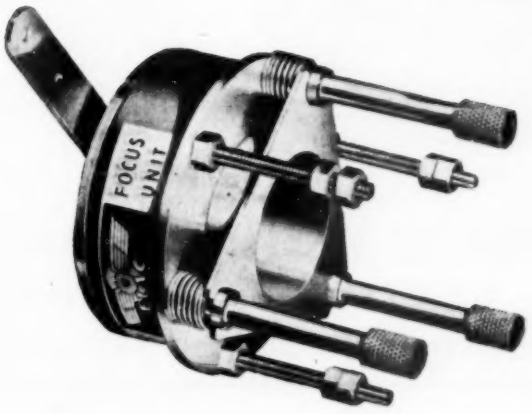

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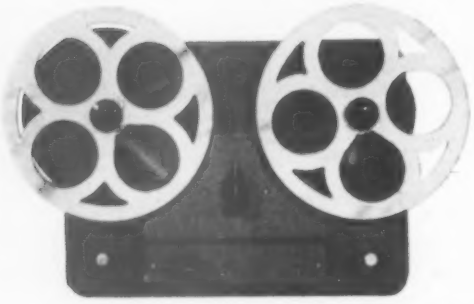
BY QUALTAPE



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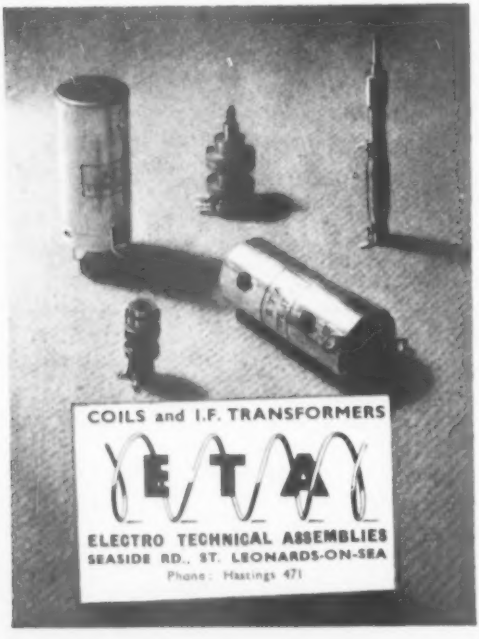

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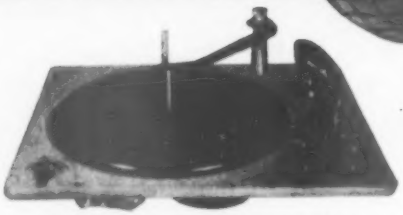

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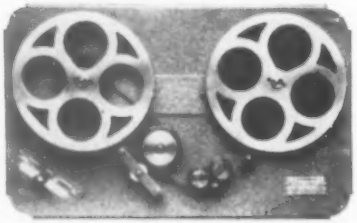

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The reproduction from records was a revelation in smoothness.

J. Moir, FMTV (review) Oct. 1951. U.S. publication.

One of the Fairs' more striking demonstrations was the playing of a recording of breaking glass in which the Acoustical speaker and amplifier combined to produce an illusion of reality so complete that listeners figuratively searched for Band-Aids to repair split fingers.

Audio Engineering (review of 1951 Audio Convention in New York).

The above passages dealing with transients are taken from reviews of Q.U.A.D. amplifier and Corner Ribbon demonstrations which have appeared in various technical publications.

Why is it that Acoustical Reproduction of Transients is so far in advance of any other equipment commercially available?

The most important criterion for good transients is that the complete chain of equipment should be aperiodic—there must be a minimum of *sharp* changes in the frequency characteristic since such changes are invariably associated with resonance.

The obvious and usual procedure is to produce a loudspeaker designed for—and sold on—its ability to give a good account of itself from average modern recordings and radio transmissions. Such a loudspeaker may be good—may be a little too good on below average programmes—may not be good enough on the best.

We prefer to use a very light treble diaphragm (0.02 grm) completely aperiodic and to control the limits electronically because of the obviously better and smoother control which can be obtained.

In the Q.U.A.D. we control the final slope *and rate of change of slope* so that this rate of change need *never* be sharper than is necessary for the programme being reproduced.

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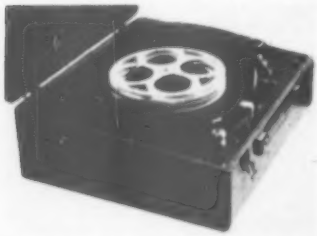

You can magnetically record, using your gramophone motor as a drive and the amplifier within your radio as the tape amplifier. Conversion Kit (readily detachable) containing all necessary parts and instructions. £7, includes postage, etc.

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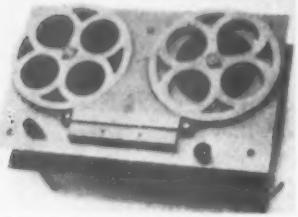

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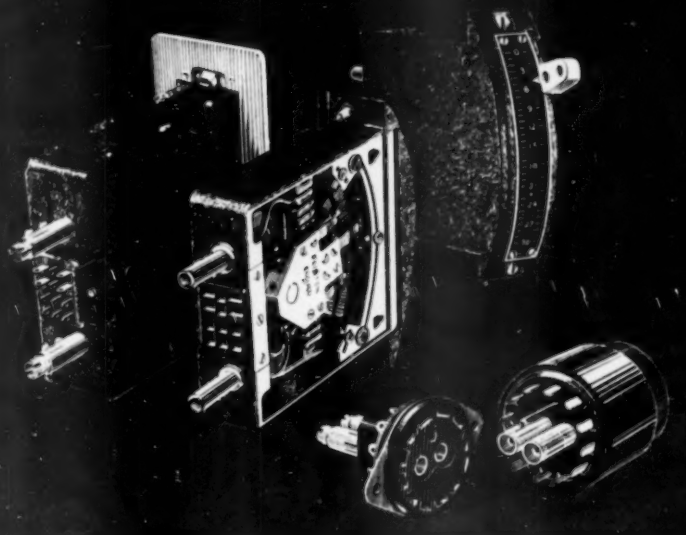

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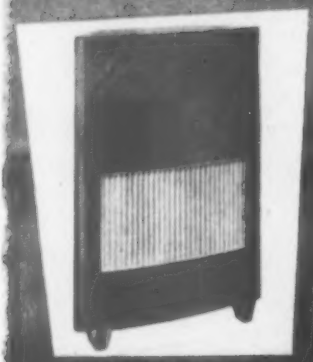

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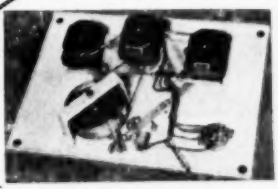

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The Amplifier is capable of giving a quality of reproduction that is only limited by the frequency response of the tapes and heads employed. The amplifier actually consists of two completely independent sections. The first section is a recording amplifier, which has provision for microphone, gramophone or radio input and mixing between these inputs is possible.

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Model 8 Meter	£23 15 0	£7 16 0	30 4
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Audio Generator H1	£25 0 0	£8 6 8	33 -
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70A Universal Meter, 1,000 ops	£12 10 0	£4 3 4	17 3
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Type 32A 2 Speed Player with pick-up	£12 1 6	£4 0 6	16 9
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Type 33B 3½ R.P.M. Player as above in Rexine case	£12 1 6	£4 0 6	16 9
Type 347 Crystal or Magnetic 3 Speed Player in Rexine case	£19 19 0	£6 13 0	25 6
Type 348 Crystal or Magnetic 3 speed Player in Walnut case	£22 1 0	£7 7 0	29 -
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1538 Three Speed non-auto	£37 5 6	£12 10 0	48 6
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Model 3 RC/521 or 511 3 Speed version of above	£12 8 9	£4 3 9	17 1
Model 3 RC/522, mixing version of above (7in., 10in. or 12in. intermixed)	£14 19 0	£5 0 0	20 -
Model AC/514, 78 R.P.M. Rim Drive	£4 16 11	£1 10 6	6 4
Model AC3/514 3 Speed version of above	£8 3 0	£2 15 0	12 4
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High fidelity high impedance	£2 6 0	—	—
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High fidelity, Xtal GP27, 78 R.P.M. (Green)	£3 2 8	—	—
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Matching transformer for this head	7 0	—	—

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RC/521/511 with GP27 head	£12 18 3	£4 14 3	17 -
RC/521/511 with Mag head	£11 16 9	£4 0 0	16 4
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3RC 511 with two high fidelity GP27 heads, 78 R.P.M. and 33⅓ 45 R.P.M.	£18 12 8	£6 4 8	24 -
3RC/522 with GP27 dual-purpose head	£19 1 9	£6 1 2	25 4
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1 Speed Auto with Amplifier	£31 3 6	£10 10 0	39 -
3 Speed Non-auto with Amplifier	£31 3 6	£10 10 0	39 -

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P.S.1. Portable in Walnut Case fitted Garrard A.C. Rim-Drive Motor, 78 R.P.M.	£12 13 9	£4 4 9	17 5
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J/T Table Model fitted Garrard Rim-Drive Motor 78 R.P.M.	£14 19 8	£5 0 0	20 -
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T/38 Table Model, fitted Garrard three speed motor and dual pick-up head	£19 18 9	£6 15 0	25 4
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C/38 Console Model fitted Garrard 3 speed motor and dual pick-up head	£30 9 0	£10 3 0	38 4
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PORTOGRAM

R.P. 50 Table Model Rim-Drive single player 78 R.P.M.	£11 7 0	£3 15 0	10 -
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ARP.3/C Console Record storage auto change 78 R.P.M.	£26 14 0	£9 0 0	33 6
RP.3/C As above but 3 speed single player	£26 14 0	£9 0 0	33 6
RP.3/1/C As above but 3 speed automatic changer	£32 11 0	£11 0 0	40 -

CONRAD

RUA 3½ R.P.M. Motor Unit	£3 8 4	£1 3 0	7 -

BURGOYNE

3 speed unit with lightweight Xtal head and auto stop in Walnut case	£13 13 0	£4 13 0	18 4

LOUDSPEAKERS

WHARFEDALE

	Cash	H.P. Deposit	12 m'l'y p'm'ts o
W.12CB	£9 15 0	£3 5 0	14 2
W.10CB or W.10CSB	£9 5 0	£3 0 0	12 9
Bronze 10in.	£3 9 6	£1 5 0	7 -
Golden 10in.	£5 15 0	£2 0 0	9 6
Bronze 8in.	£2 8 0	—	—

TERMS OF BUSINESS

H.P. : Send deposit with order which will be dispatched upon signing H.P. Agreement.

CASH : Cash with order or C.O.D. if goods suitable for post

M·O·S

Sole Distributors of the

BURGOYNE SOLDER GUN

79/6

Spare bit: 10 for 7/6.

W.B.

	Cash	H.P. Deposit	12 m'l'y p'm'ts of
10in. Concentric Duplex with trans.	£7 15 0	£2 5 0	12 6
10in. " less trans.	£6 15 0	£2 5 0	10 9
12in. " less trans.	£19 10 0	£6 10 0	35/-

GOODMANS

Audiom 60	£8 12 6	£2 12 6	13 4
Axiom 150 Mk. II	£10 5 6	£2 5 6	16 8

BAKER

12in. Triple Cone	£8 5 0	£2 15 0	12 6
12in. Single Cone	£6 15 0	£2 15 0	10/-

VITAVOX

K12/10	£8 10 0	£3 0 0	12 6

BARKER

148A	£15 15 0	£5 5 0	21/-
150	£18 18 0	£6 6 0	24 6

MILNES

10in. High-Fidelity	£12 12 0	£3 12 0	18 4

HARTLEY-TURNER

215	£14 10 0	£4 10 0	20/-

TRUVOX

12in. P.M.	£3 7 6	£1 2 6	6 9

SEPARATORS FOR LOUDSPEAKERS

Type A	Wharfedale	£3 12 6	£1 4 2	6/-
" B	"	£2 19 6	£1 0 0	5 7
" C	"	£4 12 6	£1 10 10	8 4
" D	"	£5 5 0	£1 7 6	7 10
" E	"	£2 18 6	19 6	5 7
" F	"	£2 5 0	15 0	5 0
" H	"	£3 3 6	£1 1 2	6 7

ELECTRIC SHAVERS

	Cash	H.P. Deposit	12 m'l'y p'm'ts of
Remington Contour 6	£8 19 5	£3 0 0	11 6
" Dual Voltage Contour 6	£9 19 4	£3 7 0	12 8
" Auto and Home (6 or 12 v. and Mains) Contour 6	£10 6 3	£3 9 0	13 6
" Fivesome	£8 17 7	£3 0 0	11 4
Philishaver	£6 6 0	£2 2 0	8 9
Arvin Cutsort	£2 19 7	—	—
" De Luxe	£4 16 1	£1 12 1	7 6

TELEVISION

COMPLETE VIEWMASTER KITS

	Cash	H.P. Deposit	12 m'l'y p'm'ts of
9in. Table Model less tube, valves and cabinet	£31 8 0	£10 8 0	40 3
9in. Table Model with cabinet, less valves and tube	£37 12 0	£12 12 0	48/-
9in. Table Model with valves, less tube and cabinet	£39 6 0	£13 0 0	50/-
9in. Table Model with valves and cabinet less tube	£45 12 0	£15 12 0	57 6
9in. Table Model with valves and tube (MW22-17) less cabinet	£53 2 0	£17 0 0	69/-
9in. Table Model complete with valves, tube and cabinet	£59 6 0	£19 17 6	76/-
12in. Table Model less tube, valves and cabinet	£31 9 0	£10 8 0	40 4
12in. Table Model with cabinet, less valves and tube	£37 13 0	£12 12 0	48/-
12in. Table Model with valves, less tube and cabinet	£39 9 0	£13 0 0	50/-
12in. Table Model with valves and cabinet less tube	£47 3 0	£15 3 0	61 4
12in. Table Model with valves and tube (MW31-17 or CRM121) less cabinet	£57 14 0	£19 14 0	72 10
As above but with aluminised tube (CRM123 or C12B)	£58 17 0	£19 17 0	74 9
12in. Table Model complete with valves, cabinet and tube (MW31-17 or CRM121)	£65 8 0	£21 8 0	84 4
As above but with Aluminised Tube (CRM123 or C12B)	£66 11 0	£22 11 0	84 4
9in. Console less tube, valves and cabinet	£33 3 0	£11 3 0	42/-
9in. Console with cabinet less valves and tube	£46 16 0	£15 18 0	59 5
9in. Console with valves, less tube and cabinet	£41 3 0	£13 14 0	53/-
9in. Console with valves and cabinet less tube	£54 18 0	£18 18 0	69/-
9in. Console with valves and tube, less cabinet (tube as J43)	£54 17 0	£18 17 0	69/-
9in. Console complete with valves and tube (as 543) and cabinet	£68 12 0	£22 12 0	88 4
12in. Console less tube, valves and cabinet	£33 3 0	£11 3 0	42/-
12in. Console with cabinet, less valves and tube	£46 16 0	£15 18 0	59 6
12in. Console with valves, less tube and cabinet	£41 4 0	£13 14 0	53/-
12in. Console with valves and cabinet, less tube	£54 18 0	£18 18 0	69/-
12in. Console with valves and tube, less cabinet (tube MW31-17 or CRM-121)	£59 9 0	£19 9 0	76 6
As above but with aluminised tube (CRM123 or C12B)	£60 12 0	£20 4 0	76 8
12in. Console with valves tube and cabinet (tube MW31-17 or CRM121)	£73 4 0	£24 4 0	94/-
As above but with aluminised tube (CRM123 or C12B)	£74 7 0	£24 7 0	96/-
Set of valves for Viewmaster	£8 0 0	£2 13 0	11 6

TALLON CABINETS FOR VIEWMASTER

12in. or 9in. Console Overall size 41in. × 20¼in. × 20in. Weight 55lb.	£13 15 0	£3 15 0	20/-
12in. Table Overall size 17in. × 22¼in. × 20½in. Weight 35lb.	£7 14 6	£2 14 0	11/8
9in. Table Overall size 15¼in. × 20¼in. × 16¼in. Weight 20lb.	£5 3 9	£1 3 9	15/-

Carriage and Packing 10/- extra.

CATHODE RAY TUBES

	Cash	H.P. Deposit	12 m'l'y p'm'ts of
9in. Mazda CRM92	£13 13 8	£4 15 0	18 2
9in. Mullard MW22-17	£13 13 8	£4 15 0	18 2
12in. Mazda MW31-17-18	£18 4 10	£6 9 0	25 0
12in. Mazda CRM121A B	£18 4 10	£6 9 0	23 6
12in. Brimar C12B (Alum.)	£19 7 8	£6 18 0	24/-
12in. Mazda CRM123 (Alum.)	£19 7 8	£6 18 0	24/-
12in. Brimar C12 (Alum.)	£22 9 5	£7 10 0	28 8
14in. Mullard MW36-22	£21 5 8	£7 6 0	26 8
16in. English Electric T961	£24 6 5	£8 6 6	31/-

Add sufficient for carriage and packing by passenger train.

ELECTRIC TOOLS

HANDY UTILITY

	Cash	H.P. Deposit	12 m'l'y p'm'ts of
1in. Portable Drill (HU1)	£8 19 6	£2 9 6	10 10
Vertical Bench Stand (HU2360)	£3 7 6	—	—
HU1 and HU2360	£10 7 0	£3 7 0	15/-
HU1 Horizontal Bench Stand (HU2361)	17 6	—	—
HU1 and HU2362	£7 17 0	£2 17 0	11 8
Complete 1in. Drill Kit in Metal Cab. (HU1001)	£11 15 0	£3 15 0	16 8
1in. Portable Drill (HU20)	£12 7 6	£3 17 6	17 6
HU20 Vertical Bench Stand (HU2361)	£5 10 0	£1 10 0	10/-
HU20 and HU2361	£17 17 6	£5 17 6	24/-
3in. Sander and Polisher (HU50)	£9 17 6	£2 17 6	15/-
Buffing Polishing Kit (HU1002)	19 6	—	—
6in. Electric Saw (HU60)	£17 5 0	£5 5 0	23 4
Rip Fence	8 6	—	—
Depth and Bevel attachment	£1 18 0	—	—

WOLF

6in. Bench Grinder (TG6)	£15 15 0	£5 15 0	20/-
Flex. Shaft Grinder (FP2)	£29 10 0	£9 10 0	38/-
6in. Heavy Duty Drill (WM34C)	£17 15 0	£5 15 0	20/-
Set of B.S.A. High Speed Drills for all Wolf or H.U. Drills	13 11	—	—
Wolf Cub Drill	£5 10 0	—	—
" " Bench Clamp	18 6	—	—
" " Drilling, Grinding and Polishing Set	£1 9 0	—	—
Complete Kit as above	£7 17 9	£2 12 9	12 1
Sanding, Buffing Set No. 6	£1 6 0	—	—
Drill Stand Base Set No. 1	£1 16 9	—	—
Drill Stand Pillar No. 2	19 6	—	—
Complete Wolf Cub Kit with Drill Stand	£8 11 9	£2 17 9	12 10
Lathe Set No. 4	16 6	—	—
Complete Lathe Kit	£9 8 3	£3 3 3	13 9
Saw set No. 5	£2 17 6	—	—
Complete Saw Kit	£9 12 3	£3 4 3	14/-

MISCELLANEOUS

Hellerman Tool Kit	17 6	—	—
Elco Solder Pencil 6 or 12 v.	£1 1 0	—	—
Adcola Soldering Iron	£1 12 6	—	—
" Detachable Bit	£1 10 0	—	—
Q Max Chassis Cutters with Key (1in.)	14 6	—	—
Rylock Spray Gun	£9 7 0	£2 15 0	14 4
Lifting Gear (1 ton)	£5 0 0	£1 0 0	10/-

RECORDING ACCESSORIES

MOTORS

	Cash	H.P. Deposit	12 m'l'y p'm'ts o
B.S.R. FP.10 1400 rpm clock or anti-clock	£1 18 0	—	—
" SR1 2750 "	£1 12 0	—	—
" SR2 "	£1 5 0	—	—
Collaro 1400 rpm clock or anti-clock	£1 18 0	—	—

MICROPHONES

ACOS :			
MIC 30 Hand/Desk crystal	£4 4 0	£1 4 0	8 4
MIC 22-2 table crystal	£6 6 0	£1 16 0	10 10
MIC 16-2 HI FI table crystal	£12 12 0	£4 12 0	16 8
GRAMPIAN :			
M.C.	£5 17 6	£2 0 0	9 10
LUSTRAPHONE :			
M.C high Z (CS1Z)	£5 15 6	£2 5 6	9 2
M.C low Z (CS1)	£5 5 0	£2 5 0	9 4
M.C hand type high Z (CH51Z	£8 6 0	£2 6 0	10/-
M.C hand type low Z (CH51	£5 15 6	£2 5 6	9 2
Heavy Table Base 82B	£1 6 6	—	—
Table Stand 82	£2 12 6	—	—
Moulded Table Base	10 6	—	—
RESLO :			
RV Ribbon	£3 0 0	£1 0 0	13 4
UR Ribbon	£7 5 0	£2 5 0	11 8
UR Ribbon with switch	£7 10 0	£2 10 0	11 8
Desk Stand	15 6	—	—
ROSETTE :			
RM7	£2 15 0	—	—
1110	£3 5 0	—	—

COMPLETE RECORDERS

Stingbenic (tape)	£80 0 0	£20 0 0	26/-
Wirek B2 (Wire)	£40 10 0	£13 10 0	18/9

TAPES :

	Cash
Scotch Boy, 1,200ft.	£1 15 0
E.M.I., 1,200ft.	£1 15 0
Scotch Boy, 600ft.	£1 1 0
E.M.I., 600ft.	£1 1 0
G.E.C., 1,200ft.	£1 10 0
Spools, 1,200ft.	4 6
Spools, 600ft.	3 6

M·O·S

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- ★ High input sensitivity. MIC 8 m.V. P.U. 40-60 m.V.
- ★ 5-way input selector giving accurate compensation for British, American and Long Playing records.
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- ★ A low pass filter operating at 7 kcs. and giving 40 DB per octave attenuation.
- ★ Bass lift response ideally suited to low level listening requirements.

PRICES

Pre-amplifier complete with engraved panel	£8 10 0
"RD Junior De-Luxe" amplifier and new pre-amplifier	£28 10 0
"RD Baby De-Luxe" amplifier and new pre-amplifier	£21 0 0

Full specification post free on request.

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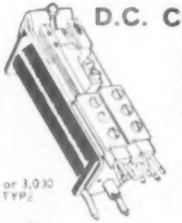
RELAYS



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ALSO LARGE STOCKS OF DOUBLE & TRIPLEWOUND AND SLUGGED COILS.

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3,000 TYPES: Make (M), Break (B), in Twin-silver Twin-platinum, Dome-silver (2 amp.), Tungsten (5 amp.), and Flat-silver (8 amp.). Change-Over (C), in all but Tungsten: Make-Before-Break (K), in Twin-silver and Twin-platinum.

600 TYPES (M), (B) and (C), in Twin-silver and Twin-platinum.

KEY SWITCHES.
2 C.O. to 8 C.O. Special types made up to order.

KEY SWITCHES

SPECIAL.
Kit of parts less chassis for photographic timer unit, ¼ sec. to 100 secs.

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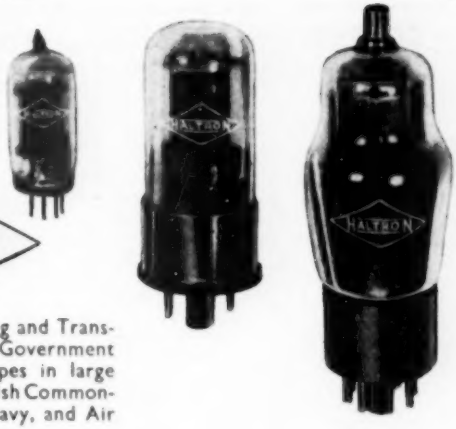

Leading Exporters of all types of Radio Receiving and Transmitting Tubes. Current Production and Ex-Government Surplus Special Purpose Tubes. Over 600 types in large quantities, available Ex-Stock. Contractors to British Commonwealth and Foreign Governments for Army, Navy, and Air Forces, Post Offices, Civil Air Lines, etc.

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1A5GT	6A6	6Q7GT	12AT7	47	811	9002	MS PEN
1C5G	6A7	6R7	12AX7	50L6GT	813	9003	NC12
1C5GT	6AB7	6R7G	12AU6	50Y6GT	814	9004	NC18
1D8GT	6AC7	6SA7	12AU7	54	815	9005	NGT5
1E7G	6AG5	6SA7GT	12BE6	57	826	9006	NR50
1G4GT	6AK6	6SC7	12C8	58	828	AR300	NT63A
1G5G	6AL5	6SF5	12H6	72/RX235	829	AR4101	NT99
1G6GT	6AM5	6SF7	12J5GT	75	829A	ATP4	OZ4
1LA6	6AM6	6SG7	12K7GT	76	329B	AU5 (VU111)	OZ4A
1LC6	6AQ5	6SH7	12Q7GT	77	830B	CL33	PEN46
1LD5	6AT6	6SH7GT	12K8	78	832	CMG25	PM4DX
1LN5	6AU6	6SJ7	12K8GT	80	832A	CY32	PM202
1R4/1294	6A8G	6SJ7GT	12SA7	81	833/833A	D63	PT15
1R5	6A8GT	6SJ7Y	12SA7GT	82	836	DA100	PX4
1S4	6BA6	6SK7	12SC7	83V	837	DET5	PX25
1S5	6BE6	6SK7GT	12SG7	84	838	DET19	R2
1T4	6B7	6SL7	12SH7	89	841	E1148/CV6	R3
1T5GT	6B8	6SL7GT	12SJ7	100TH	843	E1190	R12
2A3	6B8G	6SN7GT	12SK7	117L7GT	845	E1231	R82KA
2A5	6C4	6SQ7	12SK7GT	210VPT	860	E1248	RK34
2A6	6C5	6SQ7GT	12SL7	211 (VT4C)	864	E1271	RK39
2A7	6C5GT	6SS7	12SL7GT	220B	865	E1273	RK47
2B7	6C6	6ST7	12SN7GT	250TH	866A	E1320	RK59
2C26	6C8G	6U5G	12SQ7	262B	866JR	E1323	RKR73
2C34	6C21	6U7G	12SQ7GT	304TH	869B	E1436	RK75
2E22	6D6	6V6	12SR7	282A	872	E150	RL7
2J21A	6D7	6V6G	12Y4	304TH	872A	EBC33	RL37
2X2	6E6	6V6GT	15E	307A	874	ECH22	RT20A
2X2A	6F5	6X4	24G	310A	876	EF22	S27A
3A4	6F5G	6X5G	25A6G	311A	923	EF39	S130
3AP1	6F6G	6X5GT	25L6	313C	931A	EF50	SD5
3B7/1291	6F7	6Y6G	25L6GT	323A	954	EK32	SO12
3B24	6F8G	6Y7G	25Y5	327A	955	EL32	SP2
3BP1	6G6G	6Z5	25Z4G	328A/4320A	956	EL33	SP4
3D6	6H6G	7A4	25Z5	357A	957	GTIC	SP41
3FP7	6H6GT	7A7	25Z6G	380A	958A	GU39	SP210
3Q4	6J5	7B6	25Z6GT	388A	959	HK54	SP15297
3Q5	6J5G	7B7	30	394A	991	HL2	STV280/40
3Q5GT	6J5GT	7BP7	32	703A	1613	H24	STV280/80
3S4	6J7	7C4	33	705A	1616	HP210	TT4/NR57
3V4	6J7G	7C5	35L6GT	707A	1619	HP410	TZ20
4C27	6K6G	7C6	35T	708A	1622	HR210	TZ40
4D1	6K6GT	7C7	35TG	713A	1624	KT24	U12/U14
5B/502A	6K7	7E5	35W4	714A	1625	KT44	U18
5BP1	6K7G	7E6	35Z3	715A	1626	KT61	U19
5BP4	6K7GT	7E7	35Z4GT	715B	1628	KT66	U23
5CP1	6K8	7H7	35Z5GT	717A	1633	KTW61	VCU "C"
5FP7	6K8G	7Q7	36	724A	1642	KTW62	VCU "N"
5R4GY	6K8GT	7R7	37	725A	1960	KTW63	VP23
5U4G	6L5G	7S7	38	726A	2051	KTZ63	VR53
5V4G	6L6G	7Y4	39/44	800	4033A	L30	VR90
5X4G	6L7	8D3	40	801	7193	LD210	VR150/30
5Y3G	6L7G	9D2	41	801A	7475	LD410	VT98
5Y3GT	6N7	9D6	41MXP	803	8011	LS5	VT305
5Y4	6N7G	10	42	805	8012	M1254	VU37A
5Y4G	6N7GT	12A6	43	807	8013A	MM4	VU120A
5Z3	6P7G-2	12A6GT	45	808	8016	ML6	VU133A
5Z4G	6Q7	12AH7GT	45SPEL	810	MR10	MSP4/NR6	VU508
5Z4GT	6Q7G	12AT6	46		9001		Y63/6

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89, CHARLOTTE ST., LONDON, W.1. Phones: MUSEUM 9661 (5 lines) Cables: HALLECTRIC, LONDON

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SWG	Inch	ENAMELLED 2 ozs.	ENAMELLED 4 ozs.	TINNED 2 ozs.	TINNED 4 ozs.	COTTON COVERED 2 ozs.	COTTON COVERED 4 ozs.	SILK COVERED 2 ozs.	SILK COVERED 4 ozs.
16	.064	1/4	2/-	1/4	2/-	1/4	2/-	1/4	2/-
17	.056	1/4	2/1	1/4	2/1	1/4	2/1	1/4	2/1
18	.048	1/4	2/2	1/4	2/2	1/4	2/2	1/4	2/2
19	.040	1/4	2/3	—	—	1/5	2/3	1/6	2/5
20	.036	1/5	2/4	1/5	2/4	1/5	2/4	1/7	2/8
21	.032	1/5	2/5	—	—	1/5	2/5	1/8	2/10
22	.028	1/6	2/6	1/6	2/6	1/6	2/6	1/9	3/-
23	.024	1/7	2/7	1/7	2/7	1/7	2/7	1/10	3/2
24	.022	1/7	2/8	1/7	2/8	1/7	2/8	1/10	3/2
25	.020	1/8	2/9	1/8	2/9	1/8	2/9	1/11	3/4
26	.018	1/8	2/10	1/8	2/10	1/9	2/11	2/-	3/6
27	.0164	1/9	2/11	—	—	1/10	3/1	2/1	3/8
28	.0148	1/9	3/-	1/9	3/-	1/10	3/2	2/2	3/10
29	.0136	1/10	3/1	1/10	3/1	1/11	3/4	2/3	4/-
30	.0124	1/10	3/2	1/11	3/5	2/-	3/6	2/4	4/2
31	.0116	1/11	3/3	2/-	3/6	2/1	3/7	2/5	4/4
32	.0108	1/11	3/4	2/1	3/8	2/1	3/8	2/7	4/8
33	.010	2/-	3/5	2/2	3/10	2/3	3/11	2/10	5/2
34	.0092	2/-	3/6	2/3	4/-	2/4	4/2	2/11	5/4
35	.0084	2/1	3/7	2/4	4/2	2/6	4/5	3/1	5/8
36	.0076	2/1	3/8	2/6	4/5	2/7	4/8	3/3	6/-
37	.0068	2/2	3/11	2/7	4/8	—	—	3/5	6/4
38	.006	2/3	4/-	2/9	4/11	3/4	6/2	3/7	6/8
39	.0052	2/4	4/2	2/10	5/2	—	—	3/10	7/2
40	.0048	2/5	4/4	3/-	5/6	4/7	8/2	4/1	7/8
41	.0044	1/6 per oz.		1/9 per oz.				2/3 per oz.	
42	.004	1/9 " "		2/- " "				2/6 " "	
43	.0036	2/3 " "						3/- " "	
44	.0032	3/- " "						4/- " "	
45	.0028	4/- " "						5/6 " "	
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SWG	Enam.	D.R.C.
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17	1/6	1/6
18	1/6	1/6
19	1/6	1/6
20	1/6	1/6
21	1/6	1/6
22	1/6	1/8
23	1/6	1/10
24	1/8	2/-
25	1/10	2/2
26	2/-	2/4
27	2/-	2/4
28	2/-	2/6
29	2/2	2/6
30	2/2	2/6
31	2/3	2/8
32	2/3	2/9
33	2/4	3/-
34	2/6	3/-
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Especially recommended for use with the PREMIER MAGNETIC TAPE RECORDER.

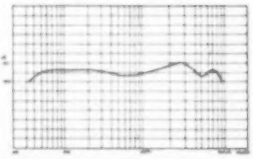
Brief Specification:—

SENSITIVITY —minus 55 db. relative to 1 v.-dyne-cm².

RESPONSE —essentially flat from 35-9000 cps., recommended load resistance 5 megohms for flat response at low frequencies.

DIMENSIONS—overall length 5¼in. Width 2¼in. at widest part of Ball Top, tapering to ¾in. at base of housing.

The Microphone is unaffected by mechanical vibrations and low frequency wind noises. An attractive black all-metal housing provides complete screening and protection for the crystal insert. The crystal is virtually unbreakable and specially treated to minimise the effect of humidity. The modern design of the Unit enables it to be used as a Hand Microphone, with a Base as a Desk Microphone, or fixed to a Pedestal Floor Stand. Screw fitting for any standard British type Stand.



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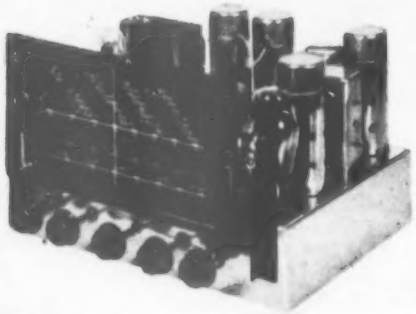

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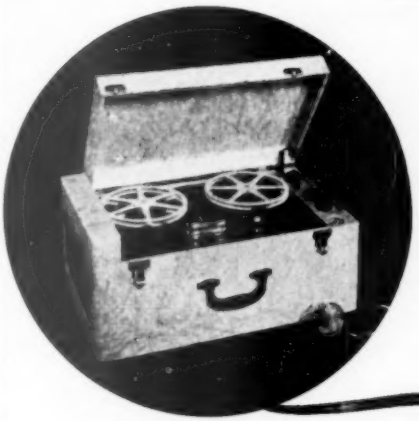

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OUTPUT :—4 Watts.

CONTROLS :—Volume ; Record/Playback Switch ; Treble Boost ; Bass Boost—on/off.

A VISUAL MAGIC EYE Record Level Indicator is incorporated.

The unit is housed in a superbly finished portable cabinet which incorporates a compartment for the Microphone when not in use. Weight complete 35 lb. Dimensions :— 21in. long ; 12½in. deep ; 9½in. high.

The **PREMIER** Recorder incorporates the **NEW LANE TAPE TABLE.**

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Made to high standards and incorporating features ensuring low level of "Wow" and "Flutter" throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run in less than 1 min. in either direction. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAYBACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record play-back head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half track size allowing approx. 1 hr. playing from standard 1,200ft. Reel of Tape.

TAPE SPEED 7½in. sec.
For use on A.C. 200/250, 50 cycles mains only.

This Recording Outfit has been designed for use with M.C.-1-111 SCOTCH BOY Magnetic Tape. With this high quality tape a frequency range of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7½in. sec. can be readily achieved.
Additional reels of 1,200 ft. can be supplied at **35/-.**

39 GNS.
(Plus Carr. & Ins. - Ign)

SUPPLIED COMPLETE WITH MICROPHONE REEL OF 'SCOTCH BOY' TAPE AND REWIND SPOOL

PREMIER TABLE MODEL MAGNETIC TAPE RECORDER

IN KIT FORM.—The Kit includes ALL parts, valves, cabinet, loud speaker, Reel of "Scotch Boy" Tape, Rewind Spool and The NEW Lane Tape Table already assembled, but excluding Microphone.

SPECIFICATION AS PREVIOUSLY ADVERTISED **£29 · 8 · 0** (Packing and Carriage 15/-)

COMPLETE—to those unable to build this TAPE RECORDER, we offer it built, tested and ready to plug in, complete with Microphone, Reel of "Scotch Boy" Tape and Rewind Spool.

SPECIFICATION AS PREVIOUSLY ADVERTISED **£36 · 10 · 0** (Packing, Carr. and Ins. 1 Gn.)

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PREMIER RADIO Company

(REGD.) RADIO — B. H. MORRIS & CO. (RADIO) LTD. — ESTAB. 40 YRS. TELEVISION

Please quote Dept. W.W.

TRANSMITTER RECEIVER TYPE TR9H

Consists of Transmitter type T1306 and Receiver R1139 in one case. This is a 9-valve Battery operated Unit, covering 4.3 Mc/s. to 7.6 Mc/s. Crystal controlled, complete with valves but less crystal. 50/-, plus 2/6 packing and postage.

EX-R.A.F. TRANSMITTER T1154 SERIES

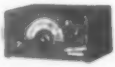
A medium High Powered Transmitter for C.W. and M.C.W. Frequency Ranges (in 2 M/c. bands) 4.3 to 5.3 Mc/s. and 5.95 to 7.6 Mc/s. A Monitor is arranged for that predetermined frequencies can be held or returned to. Complete with 4 valves (2 PT15 pentodes in parallel) driven by an M.O. in a screened Hartley oscillator circuit. A further M.O. valve provides a 1,000 cycle side tone to enable the operator to log his transmissions on C.W. Price 39 6, plus 10/- P&P and carr.

1124 RECEIVER UNIT

Range 30 to 40 Mc/s. Contains six new Valves 2-6SG, 1-6SL7, 1-12SH (frequency changer, 1-6H6, 1 current stabiliser, 6 ceramic valve-holders, 6 valve screening cans, 39 resistors, 12 pf meters, 3-gang variable condenser, ceramic coil former, 6-way 4 bank switch with long spindle I.F. transformers, etc. Brand new in maker's carton, at 22 6, plus 2/6 postage and packing.

BRAND NEW

R1155 RECEIVERS



In original cases, complete with 10 valves. Frequency range 1.5 Mc/s. to 7.5 Mc/s. in 4 wave bands. £11.19.6 10/- packing and carriage.

POWER SUPPLY UNIT

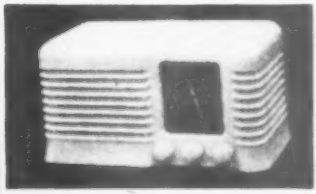
for above incorporating output stage. Supplies an output of 250 volts at 80 mA., which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage, complete with Output Transformer and 6in. speaker is built into the unit. Price £5 5/-, plus 5/- packing and carriage.

As a special offer, power supply unit including speaker together with R1155 receiver. PRICE £16.19.6. Plus 15/- pkg. & carr.

12 v. POWER SUPPLY UNIT and L.F. AMPLIFIER. A 12 v. vibrator power pack and amplifier combined. Unit contains 12 v. Mallory vibrator with filter components, 3 aluminium metal cased electrolytic capacitors, 100 v. 50 mA. 3 ATP4 tube valves, chokes, transformers and a host of other useful components. Housed in a metal case measuring 11½in. wide, 8in. deep, 4½in. high. Price 29 6, plus 5/- P&P & Carr.

POWER SUPPLY UNIT No. 7

Ref. 5A/117U. A complete Unit for charging 6-volt Accumulators by hand. Designed for the W.S.22, could be used for many other purposes. Consists of a steel metal case, dim. 12 x 10½ x 7½in., with detachable lid, containing hand driven generator with gear mechanism which delivers 9 volts D.C. at 4 amps., also 6 volt output and lighted lamp. Price 32 6, plus 5/- post/pkg.



BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TO-DAY'S PRICE

We can supply all the parts to help you.

Bakelite Cabinet (Brown or Ivory)	17 6
Packing and insurance	2 6
Punched Chassis, 3-valve plus rectifier T.R.F.	3 9
Engraved Glass Dials, 140-320 and 800-2,000 m.	1/-
With station names, two wavebands	1 6
T.R.F. Coils, 190-550, 800-2,000 metres, pair	6 6
Drum Cursor Dials	1 6
Drive Cord	1 6
Double pointer	4d
Spring	3d
Screw cord, card	6d
Dial Front Plate	2 6

SEND 1 6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.

THE COMPLETE KIT

to construct a 3-valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at £6 9 6, plus 5/- packing and carriage.

Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. The Dial is Glass-backed and the Receiver is housed in a Bakelite Cabinet size 12in. long, 7in. deep, 7in. high, presents an attractive appearance. The valve line-up is 12A. H.F. Pentode, VR116, Detector, APT4 Output, and Metal Rectifier. Wavebands coverage is for the medium and long bands. Choice of Walnut or Ivory coloured Cabinet.

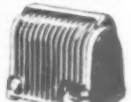
AVAILABLE ONCE AGAIN!
A.C.R. 1 C.R. TUBES
(DIRECT REPLACEMENT FOR A.C.R. 2x)

3½in. screen. 4 Volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television. 15/- plus 2/6 Pkg. Carr. and Ins. *Data sheet supplied*

V.C.R 97 C.R. TUBES

We are once again able to offer this famous tube with the usual PREMIER guarantee of a full screen picture free from cut-off. Every tube is television picture tested before despatch. £2.5.0 post paid.

PREMIER'S MOST SENSATIONAL OFFER
THE FAMOUS **'SOBELL'** 4 VALVE SUPERHET TABLE RECEIVER
M. & L. WAVEBANDS



Valve Line-up 12H1, 12H6, 12H6, 14S7, 5Z4.

Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.

Choice of 6 Colours Walnut, Pastel Peach, Ivory, Ice Blue, Arm Green, Magenta. Carrying handle incorporated in design. For use on 200-250 A.C. D.C. mains.

£8.19.6 P.P. 5/- The Cart. Ins.

Covered fully by Manufacturer's Guarantee

6v. MALLORY VIBRATOR POWER PACK

Complete with 0Z4 Rectifier Valve, input 6-8 v., output 300 v. at 90 mA. The Unit is supplied with harness assembly incorporating fused battery leads, on/off switch and output plug. Price 42 6, plus 2/6 pkg. and carr.

BRAND NEW **R1355 RECEIVERS**

As specified for the Jamieson Television, complete with 11 valves. 39 6, plus 7/6 pkg. and carriage.

SMITH'S 8-DAY AIRCRAFT CLOCKS

Luminous dial, can be supplied with trip hands as illustrated or with plain glass (note without trip hands). When ordering, please specify type required. Housed in strong black Bakelite casing. Panel mounting. Dimensions: 3¼in. dia. dial. Fixing Panel 3¾in. sq. Footprint 4in. from back. Price 42 6. Plus 1/6 post/pkg. ins.

2 STAGE QUALITY AMPLIFIER
Complete with 10in. Energised LOUDSPEAKER

4 watts output. A.C. 110/250 mains.

£6.19.6

plus 3/- carriage.

HEADPHONES
Balanced Armature Low Resistance
Type 1, 5,11 pair. Type 2, 8,11 pair.
High Resistance 12 6 pair
Lightweight High Resistance
14 6 pair

MAINS NOISE ELIMINATOR KIT

Two specially designed chokes with three smoothing condensers with circuit diagram. Cuts out all mains noise. Can be assembled inside existing receiver. 6/- complete.

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and disc recording and sound pictures. Price 22 6.

CAR BATTERIES—*BRAND NEW*

6 v. 11 plate **WALKER** Hght. 9¼in., Lgth. 7¼in., Depth 9¼in. Price 65/-.
6 v. 15 plate **READING** Hght. 7¼in., Lgth. 9¼in., Depth 7¼in. Price 75/-.
6 v. 15 plate **DELCO-REMY** Hght. 7¼in., Lgth. 9¼in., Depth 7¼in. Price 97 6.
6 v. 23 plate **DELCO-REMY** Hght. 9¼in., Lgth. 14¼in., Depth 7¼in. Price 130/-.
12 v. 9 plate **WALKER** Hght. 9¼in., Lgth. 7¼in., Depth. 9¼in. Price 110/-.

ALL PRICES PLUS 7/6 CARR. & PACKING

TUNING CONDENSERS

4-Gang 3005 mfd. Ceramic insulation, ¼in. spindle, 5/-; 2-Gang 003 mfd., ¼in. spindle 7 6.

METAL RECTIFIERS FULL WAVE

6 v. 1 amp. 4/-; 12 v. 1 amp. 8/-.
S.T.C. Pencil Type:
Output 350 v. 1 mA. 4 7 each; 1,000 v. 1mA. 6/- each

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. 50 cycle mains.
Cat. No.
2001 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator. £1.2.6
2003 Charges 12 volt accumulator at 1 amp. £1.7.6

PREMIER 3-BAND COIL PACK

Consists of a wired and aligned Coil Pack of the most Modern Type incorporating such features as Air Dielectric Trimmers. Litz wound medium wave coils. Tuned R.F. stage, covers 15-14, 40-150, 200-357 metres. Dimensions of pack: 6in. x 4¼in. x 2¼in. Complete circuit is supplied. Price 25/-.

R1170A RECEIVER UNIT
Brand New and Unused

This is a 16-valve VHF Receiver incorporating a 50 Mc/s I.F. Strip. Valve line-up: 2-6V6, 1-VU39, 2-EA50, 1-6V1SS, 1-VR137, 1-VU134, 8-EF50 valves. Price £4 2 6, plus 3/- pkg. and carr.

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IMPORTANT ANNOUNCEMENT: WE CANNOT ACCEPT RESPONSIBILITY FOR, NOR CAN WE GUARANTEE ANY—

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(REGD.) ESTAB. 40 YRS.

B. H. MORRIS & CO. (RADIO) LTD.

Please quote Dept. W.W.

RADIO

SOUND POWERED LOUD HAILER

Completely self-contained equipment by famous manufacturer. Consists of Microphone, Receiver, Speaker Unit and Matching Transformer. On-off Indicator Lamp incorporated. The Unit is 12 v. battery operated and has no complicated switching arrangement. By depressing the "Press-to-talk" switch on the Microphone the Unit comes into immediate operation without preliminary warning-up period. Completely weather-proof. 4 watts output.

£7 . 19 . 6

(Exclusive of Battery)

Plus 5/- Pkg. Carr.

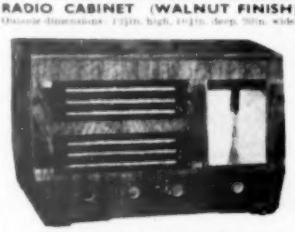
Ideal as "ship-to-shore" equipment, for Workshops, Open-air Meetings, etc. Suitable 12 v. batt., at **£5 10/-**. *Plus 7/6 Pkg. Carr.*

H.T. ELIMINATOR AND TRICKLE CHARGER KIT

All parts to construct an eliminator to give an output of 120 volts at 20 mA., and 2 volts to charge an accumulator. Uses metal rectifier. **£2**.

RADIO CABINET (WALNUT FINISH)

Outside dimensions: 12½in. high, 10½in. deep, 20in. wide.



Price **£2 2 6**, plus 7/6 carr. pkg.

SUPER QUALITY TELEVISION MAGNIFYING LENS

To suit 5in., 6in. or 7in. Tubes. Increase picture size considerably. **25/-** each.

CORRECT ASPECT WHITE RUBBER MASKS

For 12in. Round or Flat-faced Tube **16 11**

WHITE RUBBER MASKS For 6in. Tube **8 6**.

THE COLLARO 3RC511 3-SPEED AUTOMATIC RECORD CHANGER

A new large purchase enables us to offer these fine Motor Units at **NEW LOW PRICES** which are approximately 25% off the current list price. Designed for simplicity and reliability at low cost. The Pick-up can be moved to any position whilst the machine is stationary or raised without interfering with the mechanism. It is impossible to jam the mechanism and it should never go out of adjustment. The machine will play either 9-10in. or 9-12in. records not intermixed. The Motor is suitable only for A.C. supplies of 100/125 volts or 200/250 volts at a frequency of 50 cycles per second. The unit is supplied complete with the latest plug-in type Dual purpose Crystal Head, fitted with a **Permanent Sapphire Stylus**, and is suitable for use with either long-playing or standard recordings. All Pick-ups are fitted with a twin ballrace Pick-up base thus ensuring perfect freedom of movement. The Motor Plate is finished throughout in a special hammer finish and is virtually scratch proof. The complete Unit occupies a space 15in. × 12¼in. 4¼in. above the Motor Board and 2¼in. below.

PRICE £11 . 11 . 0 *Including Purchase Tax*

Plus 5/- Pkg./Carr./Ins.

ACCUMULATORS

By world-famous maker. 2 volt 10 amp. **4 11**

THE NEW BSR "MONARCH" AUTO-CHANGER

This is a 3-speed automatic mixer record changer designed to play 12in., 10in. and 7in. records intermixed in any order. Capacity 10 records, operates on 100/125— 200/250 volts 50 c/s. A.C.

New reversible dual stylus crystal pick-up has extended frequency range to 10,000 c.p.s. Self-compensated for the L.P. lower frequencies with the Turnover frequency at the correct point. **PRICE £17 17 0**, plus 5/- packing, carriage and insurance.

GARRARD ELECTRIC 'GRAM MOTOR

Induction motor 100-250 volts, 50 cycles A.C. only. The GARRARD Induction Motor is totally enclosed. Entirely free from radio frequency disturbance, magnetic hum and electrostatic. Variable speed. With 12in. Turntable. Price **£4 19 6**, plus packing and carriage 5/-.

GRAMOPHONE UNITS

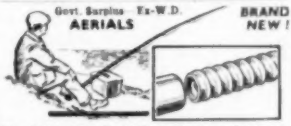
"Golden Wing" Playing Desk, consists of the famous Collaro RC500 Autochanger Unit single speed 78 r.p.m. Mag. Head, mounted on attractive metal plinth.

Ditto (Unmounted, with Mag. Head)	£16 10 0
Ditto (Unmounted, with Crystal Head)	£11 16 9
Collaro single speed rim drive Unit with plug-in Mag. Head, 78 r.p.m.	£6 10 6
B.S.R. Model GC4 2-speed Gram. Unit, incorporates the latest type of Crystal Turnover Head for long playing and standard recordings	£9 19 11
Garrard Gramophone Motor. Variable speed induction Motor. Complete with 12in. turntable (this Unit does not include Pick-up)	£5 19 6
Connoisseur 2-speed Gram. Unit LESS Pick-up	£22 18 8
Pick-up with 2 Heads for above	£10 0 8
Conrad Rim Drive Gramophone Unit LESS Pick-up Arm 78 r.p.m.	£4 3 10
Ditto, 33 r.p.m.	£4 7 5
B.S.R. 3-speed Rim Drive Gram. Unit LESS Pick-up	£6 8 6
B.S.R. Single-speed Rim Drive LESS Pick-up, 78 r.p.m.	£3 14 4
Ditto, 33 r.p.m.	£3 14 4
Decca Pick-up with 2 Heads, one long playing, and one standard	£7 0 0
Plessey Auto-changer 3-speed Mag. Head, plays mixed records	£23 13 0

Please add 5/- extra for packing and carriage charges on Gramophone Units.

ALL THE ABOVE ARE FOR USE ON A.C. MAINS ONLY

Govt. Surplus—Ex-W.D. **AERIALS** **BRAND NEW!**



10ft.—3 4ft. screw-in sections of copper-plated steel highly flexible with non-stick screws (fit tapering fin. to fit). Brand new in container. **6/9**. Also plug-in type **4/9**. Packing and carriage 1/6. Insulated Base. **3/-**.

These aerials make ideal fishing rods

EX-U.S.A. U.H.F. AERIAL

with untuned detector stage, consisting of V.R.92 valve, etc. Brand new, in carton. **5/-**.

FRACTIONAL H.P. MOTOR

A 50 v. 3-phase A.C. motor, 1/40th h.h.p. by famous maker. Supplied complete with resistor, condenser and circuit diagram to convert the motor to ¼ h.p. for use on 240 v. single phase A.C. mains. Brand new. **25/-**, plus 2/6 carriage and packing.

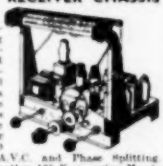
MAGNETIC MARCHING COMPASS

Luminous Dial, enclosed in black bakelite case. Size 3in. × 2¼in. × 1¼in.

Price **18/6**.

TELEVISION

A WORLD-FAMOUS *Manufacturer's Surplus of* RADIO RECEIVER CHASSIS 7-valve RECEIVER



built to exacting specifications and incorporating features ensuring superlative tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 45 Valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 K.c., using Mazda VP41. **FOUR WAVEBANDS 14 M.-34 M., 34 M.-85 M., 190 M.-550 M., 800 M.-2,000 M.** DIRECT and VERNIER TUNING. Gram. position on Switch. Provision for external Loudspeaker. For use on 200/250 A.C. Mains. **£13 10/-**, plus 21/- Pkg. and Carr.

7-VALVE SUPERHET CHASSIS

All control mountings cut out, fitted with completely assembled full vision drive scale, long, medium and short waveband and band spread. Heavy flywheel tuning. **19/6**, plus 2/6 pkg. and carr.

RADIO CABINET (WALNUT FINISH)

Outside dimensions: 16½in. high, 9in. deep, 17in. wide.

A beautifully made cabinet. **£3 10/-**, plus 7/6 carr. pkg.

5-VALVE SUPERHET RADIO CHASSIS

Drilled and cut out for all necessary control mountings and Mains Transformer, fitted with 5 Amphenol Octal Valveholders. Aerial, Earth and Gramophone Sockets. 2/00 pf Tuning Gang Condenser, full vision drive Tuning Assembly consisting of unbreakable Perspex 3-coloured scale for long, medium and short wavebands. Calibrated in metres, kilocycles and station names, price **30/6**.

AS A SPECIAL OFFER—CABINET ILLUSTRATED ABOVE AND CHASSIS, TOGETHER £5. 5. 0 Plus 7/6 Carr. Pkg. & Insurance.

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NIKAD SUPPLIES

13, Church Road, Edgbaston, Birmingham 15

W.S.18. Complete Portable Tx-Rx, freq. range 6-9 Mcs. Stored soiled. Limited number £5 each, carriage paid.

TRANSMITTER RECEIVER TYPE 1134A. Complete valves etc. Popular Tx-Rx require to SCR.522. In transit cases. Limited number £19 each, carriage paid.

R.F. UNITS. Type 25 and 27. These popular units need no further description. Limited quantity 25/- each.

CARBON PILE VOLTAGE REGULATORS TYPE E. Ref. SC.1304. Complete with metal rectifier for 80 v. A.C. 27/6 each, carriage paid.

SERIES BOOSTER. Ref. U.2712. Input 12 v., output 24 v. 27/6 each, carriage paid.

EX-A.M. COMMUNICATION RECEIVER TYPE R.1155A. Complete with 10 valves. New condition. Supplied in transit case at £9.15.0 each, carriage paid.

POWER UNITS TYPE 87. In black metal case. Size 8½ x 4½ x 6½in. 24 v. input, 6.5 v. at 2½ a. and 250 v. at 50 m.a. output. 15/- each, carriage paid.

TYPE 104. As above but 12 v. input. 21/6 each, carriage paid.

GERMANIUM CRYSTAL DIODES. Midget size with wire ends, 3/- each, post paid.

32 MFD ELECTROLYTIC CONDENSERS. 450 v. D.C. 1/9 each, post paid.

OUTPUT TRANSFORMERS. Type Z.A.20497. Designed for p.p. output of 2 x E.L.35 and capable of handling 12-15 w. Limited quantity. 17/- each, carriage paid.

HEADPHONES. Type D.L.R.1, 2 and 3 complete with lead and plug. 9/- each, post paid.

RECEIVER TYPE R.1355. New, in original transit case, complete with all valves, components etc., as specified for the "inexpensive television receiver." 50/- each, carriage paid.

ELECTRIC MOTORS made by Crompton Parkinson. 1/6th h.p. Single phase. 220-250 volts A.C. Standard r.p.m. Resilient mounting. Fitted with Thermal overload switch. New in original crates. £5 each, carriage paid.

LOUDSPEAKERS. 6½in. in P.M. made by Plessey. Less output transformer. New stock, 11/6 each, carriage paid.

MAGNETIC RELAYS 24-VOLT. Ref. SC.849. New, unused and individually boxed. Complete with outlet plug. 7/6 each. Carriage paid.

KEY AND PLUG ASSEMBLY No. 8. Z.A.4354. New condition, but not boxed. Complete plugs and straps. 7/6 each, carriage paid.

MAIL ORDER ONLY — TERMS, CASH WITH ORDER OR C.O.D. EXTRA — Satisfaction or money back guarantee

ALL ENQUIRIES S.A.E. PLEASE

TO **HAMS & DEALERS**

WE WANT TO BUY

AMERICAN SURPLUS EQUIPMENT OF EVERY KIND

FOR RADIO HAM SHACK—NEW YORK'S LEADING DEALERS

RECEIVERS • TRANSMITTERS

TEST SETS • SIG GENS

TELETYPE EQUIPMENT

EVERYTHING ELECTRONIC

We are interested in any quantity, from one upwards. 'Phone us immediately, transfer charge.

ALTHAM RADIO CO — **BRAZENNOSE ST MANCHESTER 2** — *Tel.: DEAnsgate 5387*

1 KW TELEGRAPH TRANSMITTERS. Two HF 300's output. Operation 3.5 mc to 16 mc.

RCA TRANSMITTERS. Type ET-4336. Complete with speech amplifier, crystal multiplier and VFO units. Unused and reconditioned. Can be supplied with very large quantity of spares.

RCA TRANSMITTERS. Type ET 4332 modified by R.A.F. for use on crystal or master oscillator. Complete with speech amplifier.

EX-R.A.F. 1143 TRANSCEIVERS.

NAVY MODEL COLLINS TRANSCEIVERS. TCS9, Complete sets.

No. 12 TRANSMITTERS. With coupling units, remote control, etc.

AR.-77's, S27's, NC45, HRO and others.

AUTOMATIC HIGH SPEED TELEGRAPH EQUIPMENT, "BOEHME" (U.S.A.). Up to 400 signs per minute on line and wireless.

NAVY MODEL TBY-8 TRANSMITTING-RECEIVING EQUIPMENT. Output 0.75 watts on M.C.W. telegraphy and 0.5 watts on telephony. Frequency range 28-80 mc.

All above items in excellent working condition.

Working demonstration upon request.

TX VALVES 803, 805, 807, 814, 861, 866A, DET-16 and many others.

Large stock of Tx condensers, crystals and other components. Alignment and repair of communication receivers and all other short-wave equipment undertaken.

P.C.A. RADIO

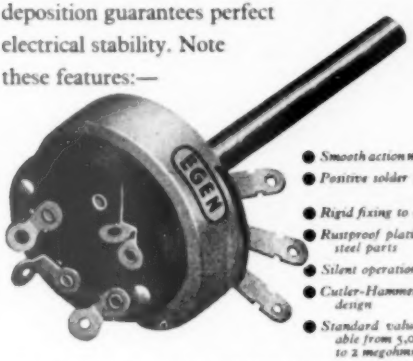
Transmitter Division :— **The Arches, Cambridge Grove, London, W.6.** *Tel. RIV 3279.*

Receiver Division :— **170 Goldhawk Road, London, W.12.** *Tel. SHE 4946*

EGEN

first and foremost!

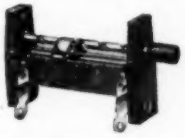
Egen Potentiometers are recognised everywhere for their dependability and are constantly being specified by radio and electronic engineers. A specialised carbon deposition guarantees perfect electrical stability. Note these features:—



- *Smooth action movement*
- *Positive solder tag location*
- *Rigid fixing to chassis*
- *Rustproof plating of all steel parts*
- *Silent operation*
- *Cutler-Hammer switch design*
- *Standard values available from 5,000 ohms. to 2 megohms.*

Egen Potentiometers are also available with single pole or double pole switch and without switch. Switches only supplied separately if required.

PRE-SET RESISTORS. A wire-wound pre-set resistor for panel or chassis mounting. Multi-unit banks available to special order.



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Overall diameter less than ½"

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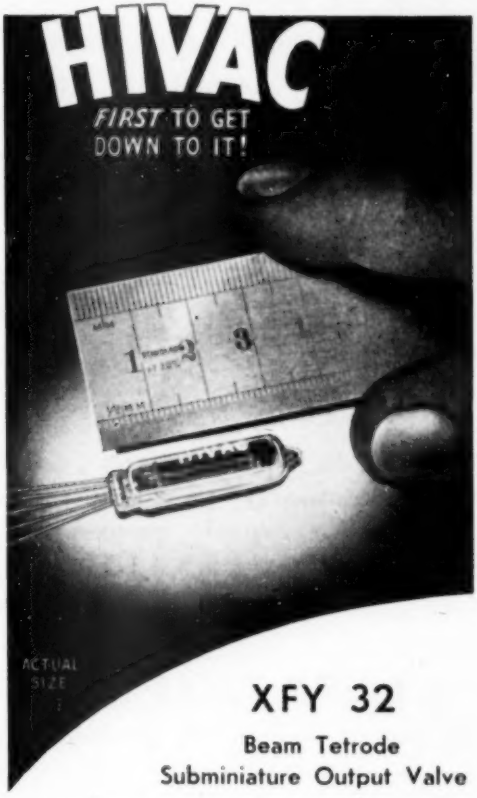

XFY 32

Beam Tetrode Subminiature Output Valve

TYPICAL OPERATION

Filament Voltage	1.25	1.25	1.25 V.
Filament Current	12.5	12.5	12.5 mA.
H.T. Voltage	16.25	22.5	30 V.
Control Grid Voltage.....	0	-1.5	-2.75 V.
Power Output.....	1.1	2.7	6.0 mW.

The maximum cross-section is only 8 mm. x 6 mm. with a maximum glass length of 35 mm. and the nominal filament current is 12½ mA.

These features, in conjunction with the high efficiency of the XFY32 permit still greater saving in space whilst maintaining exceptionally fine performance.

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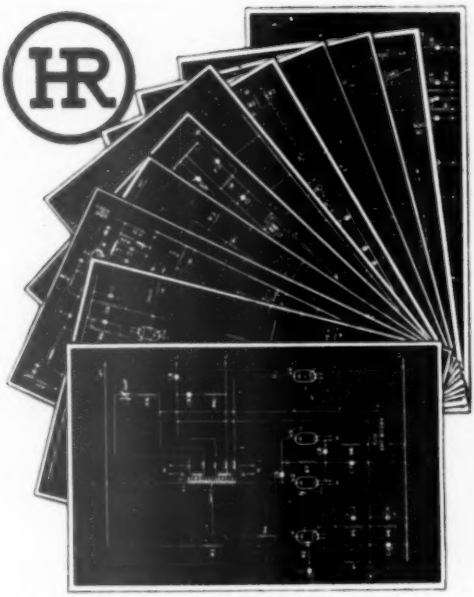

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In the manufacture of resistors we consider thermal expansions at high temperatures—of widely differing materials such as ceramics, resistance wires and protective coatings which comprise the system. At high temperatures a balance must be achieved to eliminate any stress/strain relationships in the product at room and at working temperatures. To this end thermal expansions of ceramic cores and protective coatings are accurately measured by means of a Dilatometer. Precise knowledge of this fundamental character ensures maximum reliability and stability and is evidence of our insistence upon 100% efficiency throughout production.

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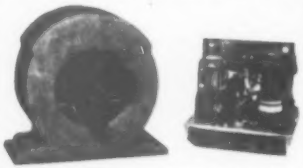
ALL KITS INCLUDE "EASY TO FOLLOW" POINT-TO-POINT WIRING DIAGRAMS

A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.
Designed to operate on A.C. mains 200/240 volts, or by an "Ability" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied, initially, as an "Ability" Battery Superhet Personal Set which can then be accommodated in the Attache Case as illustrated above (size 9½in. × 4½in. × 7½in.). This is attractively finished in dark green or blue pebble (No. 1) or as a Combined Mains-Battery Superhet Portable Receiver, for which a polished Wood Cabinet is available in accommodate both Mains Unit and Batteries together. Circuit incorporates delayed A.V.C. and Pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound Frame Aerials, fully aligned I.F. Transfs., and drilled Chassis, etc. Overall size of assembled chassis 9in. × 4½in. × 5½in.
We can supply the set either as a complete Kit of Parts for £10 7 6 (inc. P.T.) and Cabinet and Mains Unit) or by supplying the components separately. The complete Assembly Instructions, which include full price details (including prices of individual components), Circuit and Component Layout, etc., are available for 1 9 (incl. postage). Attache case as illustrated 37 6.

THE "MINI-TWIN" 1 VALVE BATTERY SET

A design of a simple 1-valve 2 Stage Battery Receiver, giving excellent results on Medium and Long Wavebands, and having exceptionally low Battery consumption.



Drilled Chassis and Practical Diagrams make it the ideal set for the beginner to build.
The complete chassis including valve can be built for 37 6, the attractive Plastic Case is 9 6, and suitable headphones 14 9.
The complete Assembly Instructions, Layouts and a Component Price List are available for 1 6.
This Receiver also performs excellently without modification, as a Tuning Unit, and in addition, with simple modifications for which a complete Diagram is provided, makes first class Preamplifier for Pick-Up or Microphone.

STERN'S "RADIO TUNER MANUAL." Price 2 6.
(Plus 3d. Post). Contains complete and detailed Assembly Instructions showing how to make:
A 1-valve T.R.F. Tuning Unit, covering long and medium wavebands.
A 4-station "Pre-set" Superhet Tuning Unit, producing 3 stations on medium waveband and 1 on long wave.
A 2-Valve Superhet Tuning Unit, covering short, medium and long wavebands.
Each Tuner is for A.C. mains operation. Circuit Diagrams and Practical Component Layouts are shown, together with complete Component Price Lists.

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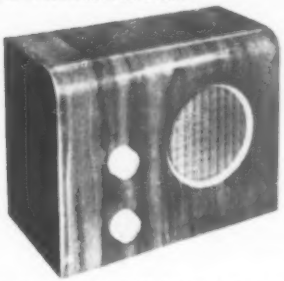
Cormorond "G.P.20," for standard records, £3 11 5; interchangeable G.P.19 Head for L.P. records, £2 3 4.
Decca (lightweight turnover Head type for L.P. and standard records, £3 19 2.
Marconi, Standard, "Lightweight" Magnetic, £1 15 10. Marconi Matching Transformer, 7 6.
Goldring, Standard, lightweight Magnetic, 35 10.

A MIDGET 4-STATION "PRE-SET" RECEIVER

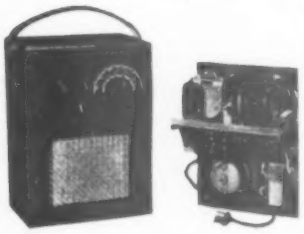
A complete Kit to build a 4-station "Pre-set" Superhet Receiver for A.C. mains operation.
The Set is designed to receive any three Stations on medium waveband and one on long wave, each Station being received by the turn of a Rotary Switch. No Tuning is necessary.
It is of midget size, being 8½in. × 4½in. × 7in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price.



Price of complete Kit of Parts (including aligned I.F. Transf. and drilled Chassis, etc.), £9 15 (incl. P.T.; plus Cabinet £5 6), or the components can be purchased separately. The complete Assembly Instructions, including Individual Component Price List, Circuit and Component Layout, etc., are available for 1 9.

THE "MINI TWO-THREE" BATTERY PORTABLE

An "Ability" Battery Portable of midget size, 6½in. × 4½in. × 7½in., designed to cover medium waveband 190-550 Metres, with use of short trailer Aerial.



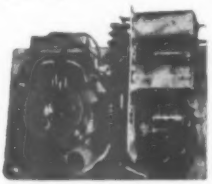
The simple design of this Receiver is so arranged that either a 2-valve Set or a 3-valve (afterwards easily converted to the 3-valve) can be made.
Consists of a T.R.F. circuit, using a Regenerative Detector with R.F. Stage, and a High Gain Output Pentode. Valveline up 1T4—1T4—1L64.
The 2-valve Set can be completely built for £4 3 6 (less Case), and the 3-valve for £5 3 (less Case). Each price includes Valves, Speaker and drilled Chassis.
Send 1 9 for the Assembly Instructions, they include simple and complete Practical Component Layouts and Diagrams which enable the most inexperienced constructor to successfully build either Set. All Components are available for separate sale, a price list being supplied with the Assembly Instructions.

THE "WIRELESS WORLD" 3-VALVE SET

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.
We are able to supply all of the components to build this set, as designed, and specified in the Feb. 1950 issue, including the drilled Chassis, Valves and moving coil Speaker, etc., at the following prices:—
To construct complete Chassis, less Dialand Drive Assembly, £5 5. Ditto, including Dial and Drive Assembly, £6.
To construct the complete Set, including Dial and Drive Assembly and Cabinet, £7 3 6.
Overall size of Cabinet is 7½in. × 3½in. × 11½in.
A reprint of the designer's article, giving Circuit and Assembly Instructions (this is available separately for 9d.) together with a Practical Component Layout is included with each of above assemblies.

THE "PRACTICAL WIRELESS" "MINI FOUR" BATTERY PORTABLE

A 4-valve Battery Superhet Receiver designed to receive 4 Pre-set Stations three on medium waveband and one on long wave to suit local conditions. Each Station is obtained on the set by the turn of a Rotary Switch. No tuning is necessary.



It is of midget size, being only 4½in. × 6½in. × 4½in. when completely built, and is very easily assembled from diagrams supplied.
Cost of all components to build this Set, in accordance with the design, including a drilled and cut chassis and panel and new valves, is £9 10 (or less valves for £8 7 6). Attractive carrying case finished in blue leatherette, 16 9. Complete constructional data with a blue print, which shows the Practical Component Layout and Wiring Diagram, together with an Individual Component Price List, is available separately, 1 6.
Our Battery Eliminators (illustrated opposite) available in all form are suitable for use with this set.

THE "WIRELESS WORLD" MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including Valves and Moving Coil Speaker for £3 10, including designers' Complete Building Instructions (these are available separately for 9d.).

★ *Send 9d. P.O. for our STOCK LIST, it shows "hundreds" of Wireless*

When ordering please include

STERN RADIO LTD., 109

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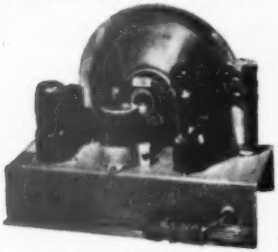
A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER

for operation on A.C. or D.C. Mains, 200-250 volts.



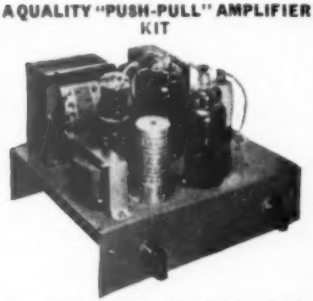
This amplifier will give 3 Watts output for the small input voltage of only 12millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H.F. Magnetic type.

A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. x 5½in. x 7in., and value line up 25Y5-12SH7-25L6.

Price of Complete kit including drilled chassis and Valves **£4 2 6**, plus 6/1in. P.M. (which fits on chassis), **16/-**, or 8in. P.M. **18 9**.

Copy of Assembly Instructions and Components Price List available for 1/3.

A QUALITY "PUSH-PULL" AMPLIFIER KIT



A Kit of Parts to build a 6-8 watt Push-Pull Amplifier for operation on A.C. mains 200-250 volts.

Incorporates a simple arrangement to enable either a magnetic, crystal, or lightweight pick-up to be used.

A 10-watt Output Transformer is designed to match from 2 to 15 ohm speakers. Tone control is incorporated.

The overall size of the assembled Chassis is 16in. x 8½in. x 7½in. high. Price of Kit complete in every detail, including drilled Chassis, and Valves, **£6 12 6**. Component Layout is supplied.

Price of assembled Chassis, supplied ready for use, **£8 2 6**.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build "Midget" "Allday" Battery Eliminator, giving approx. 69 volts and 1.4 volts.

This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 69 volts.

The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4½in. x 4½in. x 3½in. Price of complete Kit with easy-to-follow Assembly Instructions, **42 6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled Unit 7in. x 2½in. x 4½in. Price **47 6**.

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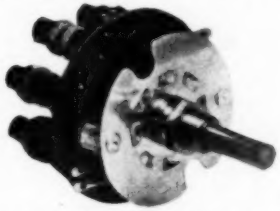
TWO NEW DENCO ULTRA MIDGET SUPERHET COIL TURRETS

Both having a Rotary Turret Action

(a) The C.T.9 Turret consists of 4-STATION "PRESET" UNIT from which any three Stations on medium waveband and one on long wave can be received by a turn of the Turret Switch.

(b) The C.T.10 Turret being a 3-wave and Coil Pack, incorporating a fourth switch position providing for completely switching out Radio when using Gram. The complete coverage is: long waveband 700 to 2,000 metres; medium waves 190 to 570 Metres and short waves 13 to 50 Metres.



The outstanding advantages these units have over other similar units can be readily seen, the main features being:

(a) Neat and compact, the overall size being only 2½in. dia. x 1¾in. deep.

(b) Fitting is simplicity itself, each Turret having one-hole fixing and requiring only four connections.

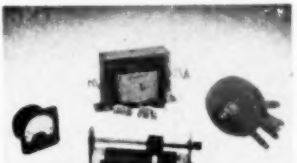
(c) The Rotary Turret design switches the actual Coils which incorporate variable iron dust cores, on to positive contacts, thereby reducing stray capacitors to the absolute minimum.

(d) They are supplied Factory wired and aligned and have been designed to operate with any conventional circuit arrangement of 465 Kc/s, and due to their unique design are extremely sensitive and efficient.

Price: C.T.9 Turret, **42 10/-**. C.T.10 Turret, **52/-**.

A complete Receiver Circuit together with leaflet containing all necessary data is included with each Turret. These can be supplied separately for **6d**.

BATTERY CHARGER KITS



All Kits incorporate Metal Rectifiers, and are for use on A.C. mains 220-250 volts. All Kits include an easily followed Wiring Diagram.

For charging 2 4-or 6-v. batteries at 1 amp. **£1 8/-**.

For charging 6-volt battery at 1 amp. with Variable Resistor and Meter, **£2 12 6**.

For charging 12-volt battery at 1 amp., **£1 9 3**.

For charging 12-volt battery at 1 amp., with variable Resistor and Meter, **£2 14/-**.

For charging 6- or 12-volt battery at 2½ amps., **£2 1/-**.

For charging 6- or 12-volt battery at 2½ amps., with Variable Resistor and Meter, **£3 8 3**.

THE FAMOUS W.B. "STENTORIAN" RANGE OF P.M. SPEAKERS

Size.	Impedance.	Watts.	Price
2½in.	2-3 ohms.	1	18 6
3½in.	"	2	19 6
5in.	"	3½	21/-
6in.	"	3	24 6
8in.	"	5 (also in 15 ohms)	32 6
10in.	"	7	36 9
10in.	"	10 (also in 15 ohms)	44 6
12in.	15 ohms	15	89

New Electrolytic Condensers. Not Ex-Govt. All 450/500 volts: 8 mfd. (1½ x 1¼in. dia.), **3/-**; 8-8mfd. (1¾in. x 1¼in.), **4 9**; 16-8 mfd. (1¾in. x 1¼in. dia.), **5 6**; 16-16 mfd. (1¾in. x 1¼in. dia.), **5 9**; 32 mfd. (1¾in. x 1¼in. dia.), **5 9**; 32-32 mfd. 350 volt, **5 9**; Cardboard Tubular 4mfd. 500 v., **3 6**; 8 mfd. 500 v., **4/-**; 16 mfd. 500 v., **5 9**. Can Standard size all 500 volts. 4 mfd., **3 6**; 8 mfd., **4 3**; 8-8 mfd., **5 9**; 16 mfd., **5 6**; 16-16 mfd., **7 9**; 32 mfd., **6 9**.

Denco I.F. Liner, for accurately lining 465 Kc/s and 1.6 Mc/s I.F. channels and associated circuits. Battery operated; small and completely self-contained. **59 6**.

Potentiometers. New, not Ex-Govt. 2K, 5K, 10K, 25K, 50K, 100K, 250K, 1, 1 and 2 meg. Price, less switch, **3 9**. Price with S.P. switch, **5 9**. Price with D.P. switch **6 6**.

Surplus Potentiometers. All standard with extended spindles. 5K, 10K, 15K, 20K, 25K, 50K, 100K, ½, 1 and 1 meg. **2/-** each.

Televisors. We keep a very comprehensive range of T.V. components. The Viewmaster T.V. Assembly Instructions showing Practical Layout and Price List in stock, price **7 6** (incl. post). We can supply all the specified components for the T.V. as stock either by way of individual components or by the published stages.

THE FAMOUS "SHAFTESBURY" RIBBON MIKE incorporating internal line Transformer having Transformation ratio from ribbon impedance up to 500-600 ohms. Reduced from £10 10/- to **£6**.

A special line to grid, 500/600 ohm, Transformer is also available for **25/-**.

Coils. Denco "Maxi Q" midget size, Litz wound on Polystyrene Formers, with adjustable iron cores. Available for Aerial R.F. and Oscillator 465 Kc/s, or 1.6 Mc/s., **3 11** each or with reaction winding, **4 9**. Denco Matched pair T.R.F. Coils for long and medium waves, **8/-** pr. Weymouth matched pairs of coils, for T.R.F. covering long and medium waves, **10 3** pr., or for Superhet covering long, medium and short waves, **12 3** pr. All types of Wearite "P" coils in stock at **3/-** each.

Coil Packs. Osmor Midget Coil Pack. Size 3½in. x 2¼in. x 1¼in., covering S., M. and L. waves. Coils wound on Polystyrene Formers with adjustable iron cores ensure efficient performance. Factory wired and aligned. Price (including full circuits for Superhet 465Kc/s. Units), **52/-** incl. P.T.s. This Osmor Coil Pack is also available for Midget Superhet BATTERY Portable Sets, including a matched ready wound Frame Aerial. Price **54 2** (incl. P.T.s). **Weymouth Midget** 2¼ x 2¼ x 1¼in. covering S.M.L. wbands, for 465 Kc/s., employing matched iron cored coils on each w band, **51 6**.

Wearite Pack. 4½ x 3¼ x 1¼in. Type 706, covers two short w bands and medium w band and Type 705 covers short-medium-long waves. Both for 465 Kc/s. Incorporates Gram. position and employs adjustable cored coils, **53 4**.

All of the above Coil Packs include Switching, Padding and Trimmer Condensers.

L.F. Chokes. Midget 10 henry 250 ohms 50 mA., **4 6**; 20 h.v.y. 250 ohms, 60 mA. **5 6**; 20 h.v. 300 ohms, 100 mA, **13/-**; 5 h.v. 50 ohms, 250 mA, **28 6**; 20 h.v. 250 ohms 120 mA, **15 6**; 5 h.v. 250 ohms 120 mA, **8 6**; 18 h.v. 200 ohms 250 mA, **26 6**.

I.F. Transformer 465 Kc/s. New well-known manufacturer's surplus, ½in. x ½in. x 1¼in. Iron core, **9/-** each and also size 1in. x 1in. x 3in. at **12/9** per pair. Each have adjustable iron cores. Denco iron core, 465 Kc/s., or 1.6 Mc/s., 1¼in. x 1¼in. x 2½in., **19 6** pair. New Surplus 465 Kc/s. Iron core, 4in. x 1¼in. sq., **10/-** pr.

Transformers. (a) Input 230 volt, output 200 volt 25 mA, and 6.3 v. 3 amp., **11 9**; (b) Input 230 volts, output 220 volts 30 mA, and 6.3 volts 1 amp., **14 6**.

E.H.T. Transformer. Prim. 230 v. Sec 2 Kv. and 4 volt tapped 2 volt, **59 9**. Do. but 4 Kv., **54/-**.

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F Wave Bridge Rectifiers

For charging 2, 4 or 6 volts at 1½ amps.	10 6
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For charging 12 or 24 volts at 3 amps.	25 9

A Variable Resistor for control of Charging Equipment for Models up to 5 amps., **17 9**, or for 1½ amps. **15/-**.

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Selenium Rectifiers. H.T. H. wave, 250 v. 50 mA, **6 6**; 250 v. 100 mA, **8 6**; 350 v. 170 mA **15 6**.

Charger Transformers. A.C. ratings, suitable for use with preceding rectifiers. Each has input of 220 volts. Outputs: (a) 24 volts tapped 15 v. 9 v. and 4v. at 3 amps. **29 6**; (b) 20 volts tapped 15 v. and 9 v. at 3 amps. **26 9**; (c) 15 volts tapped 9 v. at 3 amps. **21/-**; (d) 12 volts 1½ amps., **12 3**; (e) 15 volts tapped 9 v. at 6 amps. **25 6**; 15 volts tapped 9 v. at 1½ amps., **15 9**; 12 volts 1 amp., **7 6**.

A Battery Charger Wiring Diagram is included with purchase of Charger Transformer and Rectifier.

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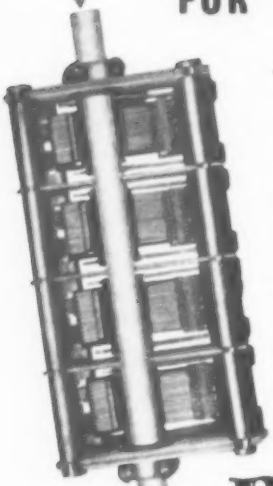

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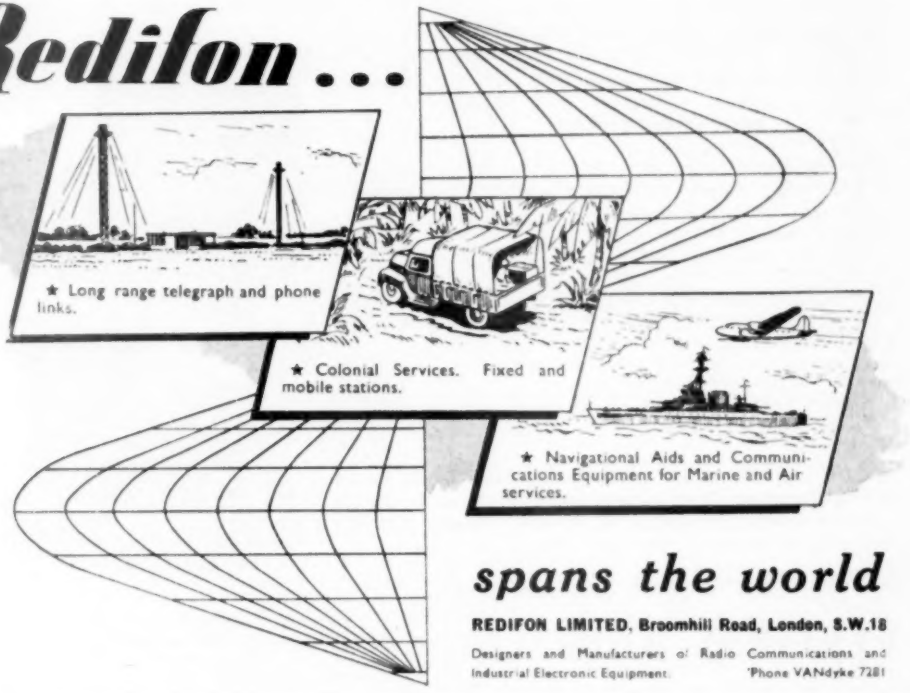
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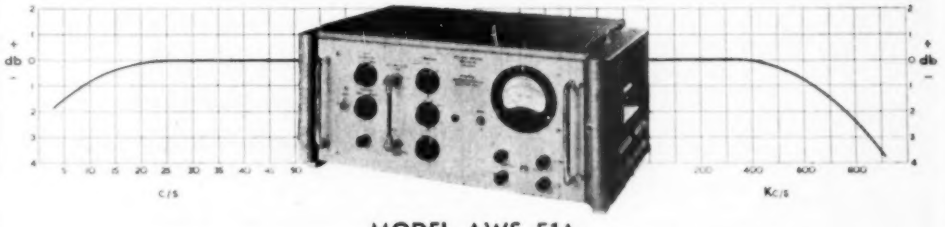

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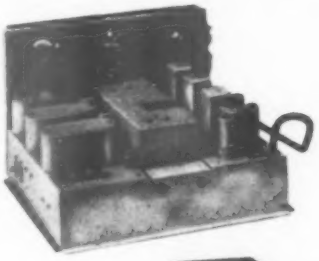
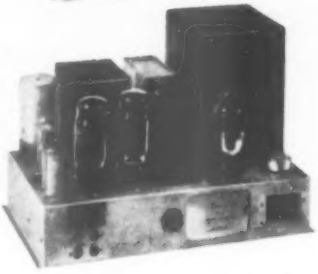


LF 612A



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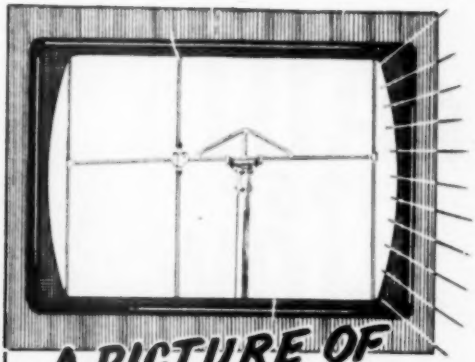

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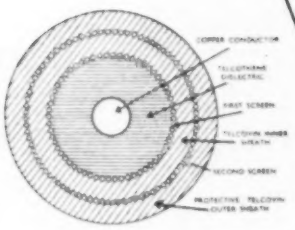

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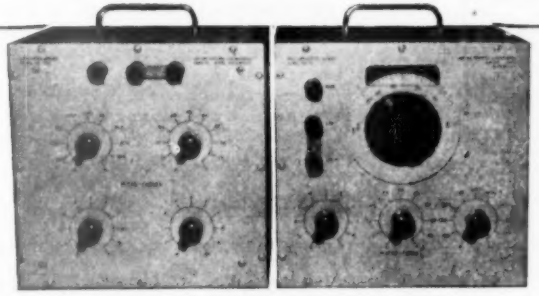
BPL



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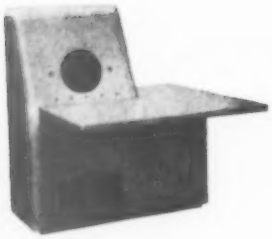

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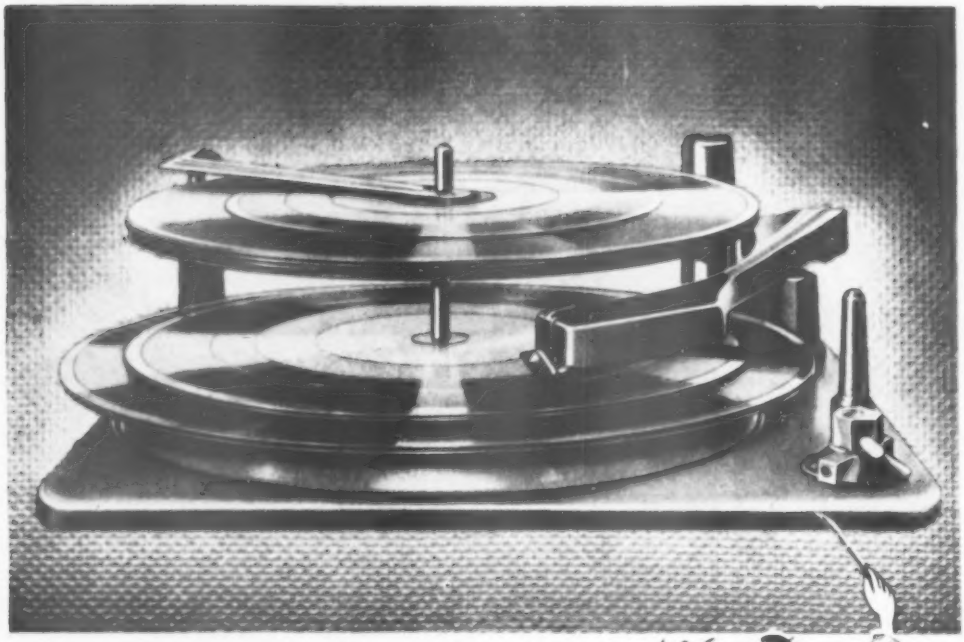

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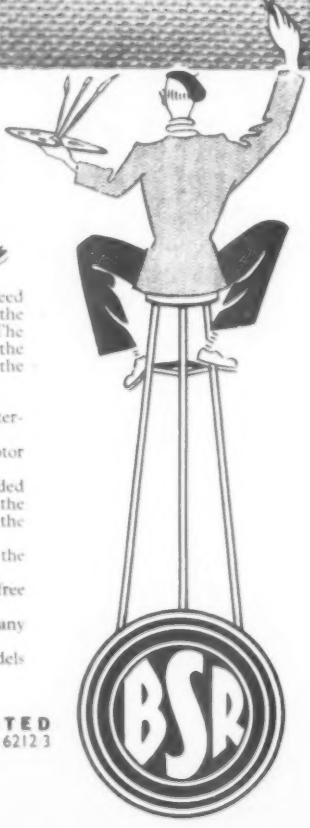

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

42nd YEAR OF PUBLICATION

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SEPTEMBER 1952

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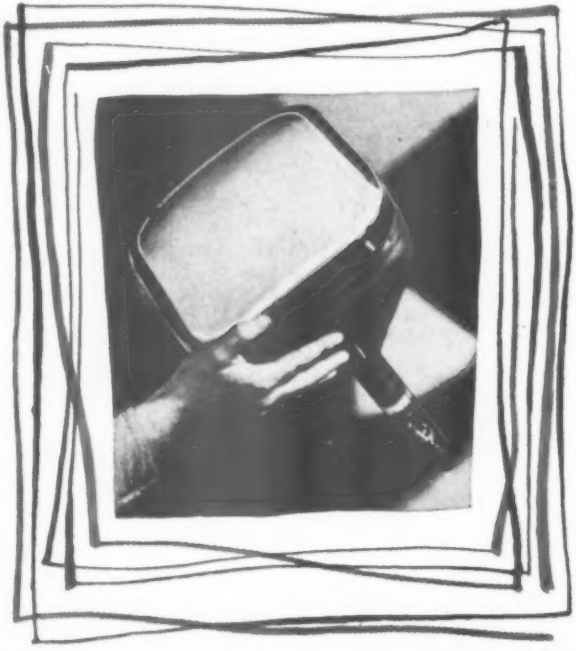
tube economy

cost of receiver maintenance is becoming an increasingly important factor in the expansion of Television in this country.

Unlike Radio, every Television receiver embodies an expendable component of comparatively high value—a Cathode Ray Tube. And yet, to maintain good standards of reception, the tube should be replaced without delay when worn.

an obvious solution, of course, is to make tubes last longer and that is what Mullard have done. Mullard Television tubes are designed specifically to maintain high performance over very long periods of service. They are thus automatically reducing the cost of maintenance and helping to bring Television within the reach of an ever-widening section of the public.



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Wireless World

SEPTEMBER 1952 VOL. LVIII. No. 9

Showing the Public

THE 1952 National Radio Exhibition, opening today, is planned to follow a slightly different pattern from that of its immediate predecessors. As in recent years, it will be primarily a show of domestic broadcast receivers, with television in the foreground. Commercially, other branches of the industry will not be fully represented, but the organizers have arranged a number of non-commercial or semi-commercial exhibits aiming to show laymen some of the non-broadcast uses to which radio and radio-like devices can be put. There is also to be some emphasis on technical training, and space will be devoted to exhibits of an educational nature.

If all branches of the industry cannot be fully represented at the annual show, it is all to the good that the public should see that radio means something more than broadcasting.

Tax on Progress

THE Government has decided to impose a Purchase Tax of 66⅔ per cent on apparatus used for broadcast relay reception. When radio receivers are subject to the same tax, that may be fair enough, but what is particularly unfortunate is that all loudspeakers, whether for relay or direct radio reception, are to be taxed. That section of the industry which protested against unfair differentiation in favour of the relays can hardly have expected this outcome.

To tax all loudspeakers seems to us to be putting a barrier in the way of progress. The loudspeaker is admitted to be the weakest link in the chain of sound reproduction, and so is most susceptible to radical improvement. A rich reward awaits anyone who finds a better way of converting electrical impulses into sound, but we imagine that those who hold the purse-strings will now think twice before allocating money to loudspeaker research.

British sound-reproduction equipment enjoys an excellent and well-deserved reputation abroad, and is already a substantial dollar-earner. Any Government action that tends to curb development in this highly promising field is especially to be deplored.

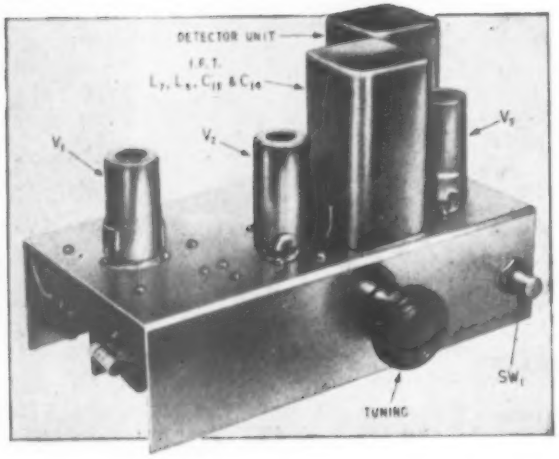
Administratively, there seems to be no convincing argument for dragging *all* loudspeakers into the Purchase Tax net. The number of broadcast relay companies is quite small, and it should be easy to collect the tax only on those speakers to be used for wire distribution networks.

The Heart of Our Affairs

UNTIL quite recently radio men were content to shunt messages along their ether channels in the form of signal elements called bauds. Nowadays, the new science of Information Theory, explained on another page, suggests that we must get to grips with the stuff of which the messages themselves are made. Information should now be measured properly, in units of its own; our crude bauds must become well-defined "bits". Hartley showed how information was *related* to the electrical properties of the channel, but Shannon tells us *how much* of it we can send.

The subject can hardly be ignored any longer, even by technical isolationists who have hitherto been in the habit of making the means—and not the end—of radio their sole concern. Radio engineers have already been forced to take into account the information-carrying capacity of their channels, the width of which is being more and more jealously restricted. The goods may have to be delivered at a certain—and sometimes quite high—rate (as in television, for example) and if the channel is too narrow to handle the traffic in a straightforward way, the technician must get to work to repack the goods—that is, to reshape the information itself.

According to the newer way of thinking, information is something more than goods in transit; it is the raw material of communication, to be processed before despatch. Of late this has been increasingly accepted, and a symposium of papers on the practical applications of Information Theory is being presented at the I.E.E. in September. From what the exponents of the new Theory tell us, it seems extraordinary that we have been able to ignore "information" for so long.



The valves, i.f. transformer and discriminator unit only are on top of the chassis.

F.M. FEEDER UNIT

Part 1.—Circuit Details of a Simple Inexpensive 3-valve Adaptor

By S. W. AMOS,* B.Sc. (Hons.), A.M.I.E.E., and G. G. JOHNSTONE,* B.Sc. (Hons.)

THE unit described in this article is designed to cover the v.h.f. broadcast band 87.5–100 Mc/s, and in particular to receive the B.B.C. experimental f.m. transmission radiated on 91.4 Mc/s from Wrotham, Kent. It delivers a signal suitable for operating an audio amplifier and requires an h.t. supply of approximately 30 mA at 250 V (but will operate with an h.t. as low as 150 V) and an l.t. supply of 0.8 A at 6.3 V. The feeder unit could be used in conjunction with an existing receiver by connecting the a.f. output to the gramophone input terminals, but a separate mains unit will then most likely be required. The aerial input is suitable for an unbalanced 80-ohm input, and is made via a co-axial plug and socket; the a.f. output is obtained from a similar socket. The power supplies are made via a multi-pin plug and socket, all three sockets being at the rear of the chassis.

The feeder unit is constructed on a chassis of 16 s.w.g. aluminium measuring 7½in by 4in by 2in and has two controls only, namely a tuning control covering the range 87.5–100 Mc/s and a spring-loaded switch used to locate the correct tuning point. No manual gain control was thought necessary because such a control is usually incorporated in the following audio amplifier. Three B7G valves and two crystal diodes are employed and Aladdin formers (moulded bakelite type PP 5892) are used throughout.

The complete circuit diagram of the unit is given in Fig. 1. It employs a superheterodyne circuit with an EF95 (6AK5) as r.f. amplifier, an EF91 (6AM6, Z77 or 8D3) as frequency changer, a second EF91 or equivalent as i.f. amplifier at 10.7 Mc/s and two crystal diodes in a ratio detector circuit. A double diode valve of the EB91 type could be used in place of the two crystal diodes and the relative merits of valve and crystals are discussed more fully later.

In spite of its inferior sensitivity, the ratio detector was chosen in preference to the Seeley-Foster discriminator because it can be made unresponsive to amplitude-modulated signals[1, 2, 3] and this avoids the necessity for a separate limiter stage; the detector driver valve can thus operate at maximum gain. As pointed out by Maurice and Slaughter[4] the sensitivity of the i.f. valve and detector combination is higher using a ratio detector than using a Seeley-Foster discriminator.

The operation of this form of detector is described in detail elsewhere[1, 4] but a brief summary is given below. The centre tap of the secondary winding L_{11} of the second i.f. transformer is connected to a small winding L_{10} closely coupled to the primary winding L_9; when the transformer is properly aligned, at the midband i.f. frequency the r.f. potential across each half of the secondary winding is in quadrature with the p.d. developed across L_{10}. Thus the p.ds between each end of the secondary winding and earth are equal and both diodes consequently receive equal r.f. inputs. If the i.f. signal frequency differs slightly from the midband value the p.ds across each half of the secondary winding, though still equal, are no longer in quadrature with the p.d. across L_{10} and the diode inputs are no longer equal. The interconnection between primary and secondary is similar to that of a Seeley-Foster discriminator, but the significant point about the ratio detector is that the two diodes are connected in series aiding whereas in the Seeley-Foster circuit they are connected in series opposing. For a signal at midband frequency both diodes conduct and the p.ds developed across the load circuit R_{15}-R_{16} are directly proportional to the signal input. The midpoint of this load is earthed and the potential at the lower end of L_{10} is also that of earth. If the signal frequency

* B.B.C. Engineering Training Department.

[1] The Ratio Detector. S. W. Seeley and J. Avins. *RCA Review*, June, 1947.
[2] FM Ratio detectors. R. G. Peters. *Communications*, November, 1945.
[3] Ratio Detector is insensitive to AM. *Electronic Industries*, November, 1945.
[4] FM Reception. D. Maurice and R. J. H. Slaughter. *Wireless World*, March, 1948.

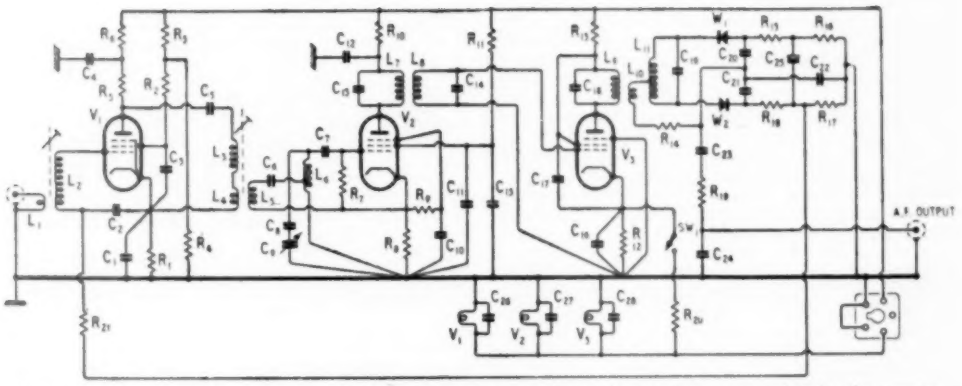
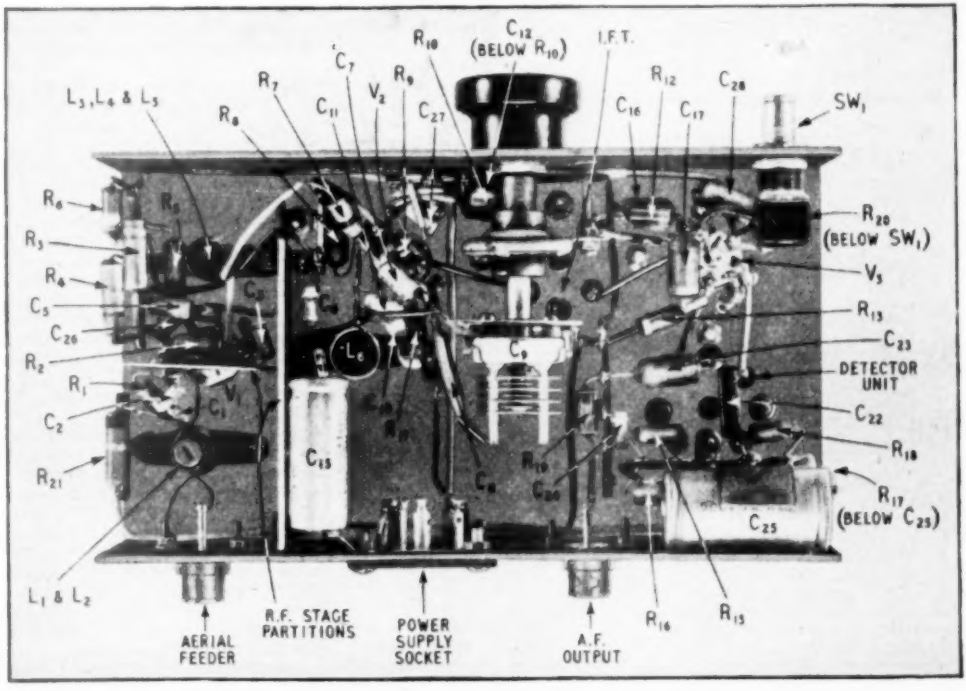


Fig. 1. Complete circuit diagram. Several of the components associated with the ratio detector are included in the screening can and cannot be found on the annotated illustrations. These will be discussed in the second part of the article.

alters the r.f. input to one diode increases and to the other decreases with the result that the potential at the lower end of L_{10} increases positively or negatively depending upon the direction of the frequency variation. When a frequency-modulated signal is applied, the output at the lower end of L_{10} is the modulation signal. For successful operation of the detector it is essential that the p.d. across the diode load should be constant in spite of frequency fluctuations of the incoming signal; this is achieved by shunting the load with a high-value capacitor to give a time constant long compared with the period of the lowest modulation frequency.

The p.d. across the diode load, or more strictly one-half of it since the midpoint is earthed, can be used for a.g.c. and in this receiver is applied to the

Underside of the chassis showing the layout and position of the components. Comparison with the circuit diagram will enable them to be identified.



r.f. stage; this is preferred to returning a.g.c. to the i.f. stage, for whilst it will cause mistuning in either case, in the latter it will also cause considerable distortion. Components $R_{14}C_{24}$ are for de-emphasis and also serve as additional r.f. decoupling in the audio output.

The ratio detector is not completely unresponsive to a.m. signals and the rejection properties derive from the steady voltage maintained across C_{25}. Whilst it was assumed above that the total diode output voltage should be stabilized, this is not the best condition for a.m. rejection. There is an optimum ratio of the d.c. output which should be stabilized and this depends upon a number of considerations. In this circuit approximately 0.85 of the detector output should be stabilized for optimum a.m. rejection, and this requires the sum of R_{15} and R_{18} to be 2.5 kΩ. If, however, the detector circuit is unbalanced due for example to crystal inequalities an improvement in a.m. rejection may be obtained by varying the values of R_{15} and R_{18}, keeping the total resistance constant. However this form of correction will not hold for all signal levels and should be adjusted under working conditions. This can be done conveniently by tuning the receiver to the Wrotham a.m. transmission on 93.8 Mc/s and adjusting the values of the resistors for minimum a.f. output. The resistor R_{16}, by modifying the diode peak currents, serves to effect a further improvement in a.m. rejection. Provided the receiver is properly aligned, a.m. rejection is best when the receiver is accurately tuned to the carrier; the rejection deteriorates as the receiver tuning is displaced to either side.

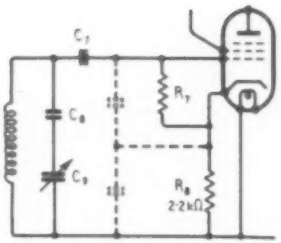


Fig. 2. Details of the oscillator circuit as described in the text.

A double-diode valve or two crystals can be used in the detector. In general the valve gives a superior performance because the characteristics of the two halves are usually more stable, but crystals make for neater and more compact construction because they can be mounted with some of the low-value associated capacitors inside the detector unit. If crystal diodes are used they should, if possible, be well matched. The authors have experienced some trouble with crystal diodes particularly cheap surplus types due to variation in characteristics with mechanical shock and with time. Amongst others, CG1C and CG6M (B.T.H) have proved satisfactory but a pair costs about the same as a diode valve. For constructors intending to use a double diode valve there is sufficient space on the chassis without any changes in layout but the second i.f. transformer needs slight obvious changes in construction.

The winding details of the detector unit, as well as the circuit values in the detector itself are taken, with permission, from an article by Seeley and Avins[1].

The i.f. amplifier V_3 has a conventional circuit but three points are worthy of mention. The screen decoupling capacitor C_{17} is returned to the cathode pin to avoid possibility of instability. The components R_{13} and C_{16} are connected between the cathode pin and the i.f. transformer lead-out wire, the latter being earthed. The switch SW_1 is a spring-loaded push-button type used to locate the correct tuning point; when pressed it injects 50-c/s hum from the heater supply into the cathode circuit and amplitude modulates the i.f. input signal. This produces audible hum in the a.f. output of the receiver, which has a minimum value when the receiver is correctly tuned.

The first i.f. transformer is quite conventional and is tuned to the midband frequency of 10.7 Mc/s. This particular value was chosen because it enables the bandwidth necessary (about 300 kc/s) to be obtained readily whilst still permitting a stage gain of nearly 100 using a valve of the EF91 type. To obtain a high L/C ratio the coils are tuned partly by the valve interelectrode capacitances, 10 pF of fixed physical capacitance only being used. This results in some variation in i.f. tuning due to changes in valve interelectrode capacitances particularly during the warming-up period. This effect is not severe but the i.f. alignment should be carried out after the receiver has been operating for at least ten minutes.

The frequency changer is an EF91 connected in an

LIST OF COMPONENTS

Resistors

R_1 180 Ω	R_8 2.2 kΩ	R_{15} 1.2 kΩ*
R_2 270 Ω	R_9 47 kΩ $\frac{1}{3}$ W	R_{16} 6.8 kΩ†
R_3 22 kΩ	R_{10} 1 kΩ	R_{17} 6.8 kΩ†
R_4 47 kΩ 1 W	R_{11} 5 kΩ	R_{18} 1.2 kΩ*
R_5 10 kΩ 1 W	R_{12} 180 Ω	R_{19} 39 kΩ
R_6 1 kΩ	R_{13} 1 kΩ	R_{20} 470 Ω
R_7 33 kΩ	R_{14} 47 Ω	R_{21} 10 kΩ

* Adjusted for best a.m. rejection: sum of $R_{15}+R_{18}$ to equal 2.5 kΩ always.

† Close tolerance

All resistors $\frac{1}{2}$ W unless otherwise stated.

Capacitors

C_1 0.001 μF miniature ceramic	C_9 Air space variable 15 pF max.	C_{18} 10 pF C_{19} 35 pF C_{20} 300 pF
C_2 0.001 μF miniature ceramic	C_{10} 0.001 μF miniature ceramic	C_{21} 300 pF C_{22} 300 pF
C_3 0.001 μF miniature ceramic	C_{11} 0.001 μF miniature ceramic.	C_{23} 0.01 μF 350 V d.c. C_{24} 0.002 μF
C_4 0.001 μF miniature ceramic	C_{12} 0.001 μF 350 V d.c.	C_{25} 8 μF Electrolytic.
C_5 50 pF	C_{13} 10 pF C_{14} 10 pF	C_{26} 0.001 μF miniature ceramic.
C_6 0.001 μF miniature ceramic	C_{15} 4 μF Electrolytic.	C_{27} 0.001 μF miniature ceramic.
C_7 50 pF	C_{16} 0.01 μF 350 V d.c.	C_{28} 0.001μF 350 V d.c.
C_8 20 pF*	C_{17} 0.01 μF 350 V d.c.	

* Adjusted to give correct tuning.

Valves
V_1 EF95, 6AK5.
V_2, V_3 EF91, 6AM6, Z77, 8D3.
W_1, W_2 Crystal diodes.

Chassis Fittings.
Aluminium chassis 7½ × 4 × 2in
Switch SW_1 Single-pole on-off spring-loaded push type.
3-B7G valveholders with screens.
2-Co-axial sockets.

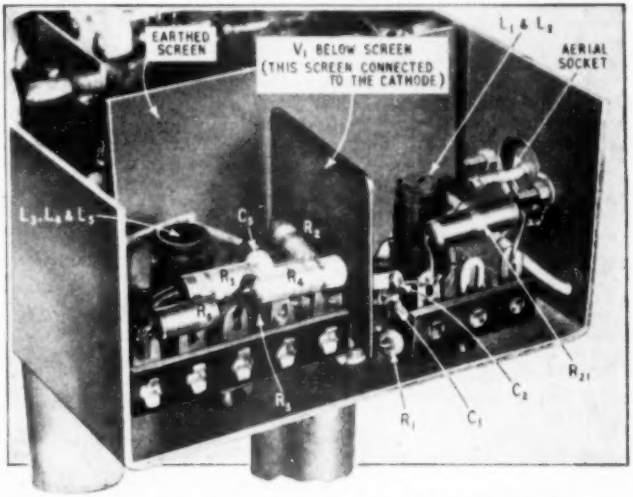
unconventional circuit, adopted after numerous experiments, because of its high conversion conductance; the stage gain of this frequency changer is, in fact, nearly ten times that of a more orthodox circuit used in early versions of the receiver. The oscillatory circuit L_4, C_{14}, C_9 is a cathode-coupled Colpitts arrangement operating below the signal frequency, positive feedback being obtained via the grid-cathode and cathode-heater capacitances of the valve, shown dotted in Fig. 2; this is a convenient form of oscillator because it makes use of the full g_m of the valve, i.e., the change in total space current per volt change of control grid potential. For this reason the oscillator gives good amplitude with an h.t. supply as low as 150 volts.

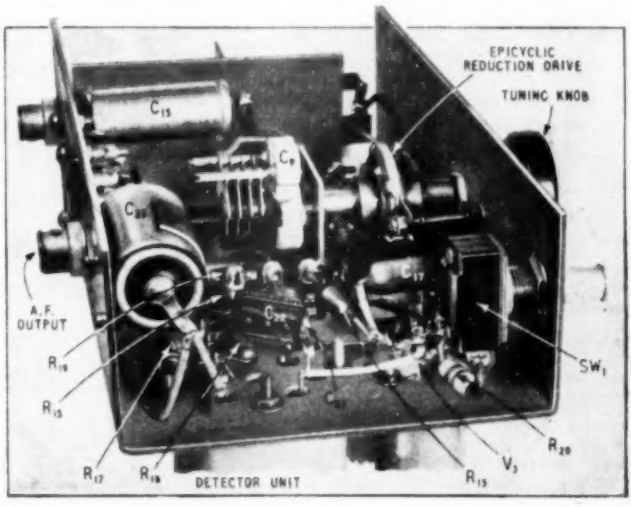
With this form of oscillator the cathode-earth capacitance is an essential part of the positive feedback circuit and the cathode cannot therefore be earthed. The d.c. cathode return is sometimes made via an r.f. choke but in this receiver a 2.2 kΩ resistor has proved satisfactory. Because of this resistance the cathode is approximately 20 V positive with respect to earth and the suppressor grid must not therefore be returned to earth, otherwise undesirable negative suppressor bias is obtained. The suppressor grid is returned to cathode as shown in Fig. 1. The tuning capacitor C_9 has approximately 15 pF maximum capacitance, but this is reduced by a fixed series 20-pF capacitor C_{10} which limits the frequency swing of the oscillator to give the desired frequency coverage. The oscillator inductance is adjusted by the dust-iron core to fix the limits of the band. The tuning of the receiver is not at all critical and in all but the latest versions, the tuning capacitor was varied by direct rotation of the capacitor shaft, but an epicyclic slow-motion drive was fitted on the model illustrated. With this, the tuning is less critical than on most medium-wave receivers.

The signal-frequency input to the frequency changer is connected between the cathode of V_2 and a tapping point on the oscillator coil. This may be regarded as an approximation to a hybrid-coil arrangement and the correct tapping point is that for which the oscillator output measured between the tapping point and V_2 cathode is a minimum. If the position of the tapping point is correctly chosen, variation of the tuning of V_1 anode circuit has virtually no mistuning effect on the oscillator circuit. For the receiver illustrated the oscillator amplitude was 12 V peak between grid and earth and the minimum p.d. obtainable between the tapping point and cathode was just over 1 V peak; this tapping point was 1¼ turns from earth, the coil having a total of 4 turns. To facilitate making tapping points, the oscillator coil was wound with tinned copper wire (18 s.w.g.). The position of the tapping point does not seem to depend very greatly on the type of frequency changer valve used and a 6AM6, an 8D3 and a Z77 have been used with very little change in performance.

H.T. smoothing (C 15) is included in the screen supply to V_2 to suppress a slight hum which was audible in the a.f. output; this was traced to frequency modulation of the oscillator by ripple on the h.t. supply. The smoothing circuit may not be necessary if the unit is fed from a well-smoothed h.t. supply.

The signal frequency input to the frequency





Above is shown a close-up view of the input end of the chassis and, below, a photograph of the output end. It should be noted that the small screen connected to cathode (top photograph) must not touch the adjacent earthed screen.

changer has both "legs" at r.f. potential and is obtained from V_1 anode by a 1 to 1 r.f. transformer, the details of which are given in a later part of this article. Tight coupling is required between these windings, and the dust iron core is arranged to be at the centre of the transformer. A considerable improvement in r.f. transfer from the anode of V_1 to the grid of V_2 was obtained by feeding the primary of the r.f. transformer, L_4, via a series inductor L_3. The series inductor must be tuned to give maximum transfer and this is achieved by winding the coil as a continuation of L_4, with a suitable spacing between. Full details are given later.

An EF95 was chosen as r.f. amplifier because experiments showed it capable of substantially greater gain at 90 Mc/s than the EF91-type used in the other two stages; the improvement is due to the higher input impedance of the EF95. The EF95 is provided with two cathode pins (2 and 7) and a copper sheet 1¼in square is soldered to the corresponding valve-holder lugs and the small cylindrical screen at the centre to act as a shield between the anode and grid circuits. It must be remembered that the copper screen, although at zero r.f. potential, is approximately 2 V positive with respect to earth, and must not come into contact with any earthed conductor. Both grid and anode compartments are screened from the frequency changer by an aluminium shield bolted to the chassis, and nearly equal to the width of the chassis.

To avoid any possibility of oscillation, the screen grid and control grid circuits of the r.f. amplifier are decoupled to cathode as shown in Fig. 1. The screen grid is fed from a potential divider consisting of a 22-kΩ resistor R_3 and a 47-kΩ resistor R_4 connected across the h.t. supply; these are necessary to prevent the screen potential rising unduly (and possibly causing excessive screen dissipation) when the r.f. valve is biased back by a.g.c. This potential divider gives an a.g.c. action superior to that of a single series resistor. R_2 is included to prevent parasitic oscillations, which might otherwise be caused by the long screen supply lead. A.G.C. causes a certain amount of mistuning of the grid circuit when the receiver is tuned to a strong signal, but this is not considered serious because the circuit is damped by the aerial matching circuit, and the valve input resistance. Some form of a.g.c. is essential if crystals are used in the detector, because these are usually rated for a certain maximum r.f. input which cannot be exceeded without risk of permanent damage to the crystals. It is easily possible to exceed this maximum input for certain types of crystals if the receiver has no a.g.c. and is tuned to a strong carrier. The a.g.c. also simulates the function of the limiter used with a discriminator by tending to make the output amplitude independent of input carrier amplitude.

The tuning of the r.f. valve grid and anode circuits is fixed at the mid-band frequency, and is adjusted by the dust-iron cores in L_1 and L_2. Both circuits resonate with valve capacitances, no fixed physical capacitance being used.

The aerial is connected to a 1-turn coil wound over the earthy end of L2 (5 turns); this gives maximum voltage transfer with an 80-ohm source, i.e., a single dipole aerial.

In the concluding part of this article details of all the coils will be given, and the alignment procedure will be described. There will be also information on suitable aerials, together with receiver performance details.

To be concluded.

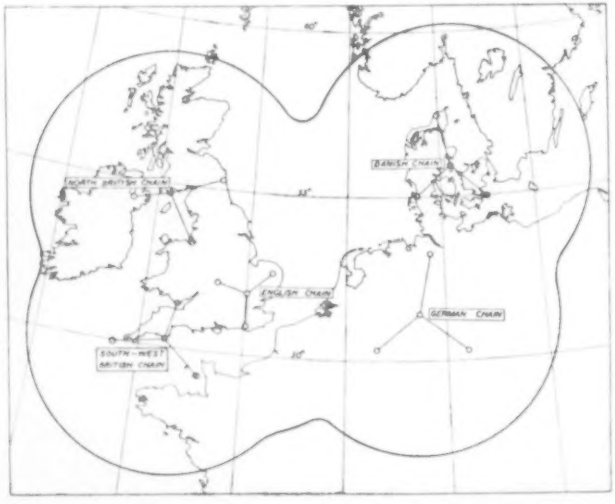
Decca Navigator

New British Chain Opened : European Coverage Extended

WITH the opening of the fifth chain of Decca Navigator stations—the South West British on 29th July—all the approaches to the British Isles and the major part of Europe are now covered by this position-fixing system for marine and air navigation.

The latest chain follows the accepted three-pointed star shape geographically, with the central station near Plymouth. The Red Slave station, so called because in conjunction with the Master station it generates the pattern of the position lines printed in red on the charts, is in Jersey. The Green and Purple Slaves are, respectively, on St. Mary Island in the Scillies, and at Llancarffan, near Cardiff.

As will be seen from the map the new chain covers the south-western approaches and closes the gap which previously existed between the North British and English chains. Although cited primarily as an aid to shipping it will add considerably to the Decca coverage for European air traffic.



Noise Limiters for Television Sound

By
R. T. LOVELOCK,* A.M.I.E.E.

Use of Germanium Rectifiers

SEVERAL forms of electrical equipment generate strong interference signals in the television frequency spectrum, but by far the commonest form is that radiated by the ignition system of a petrol engine. It is possible to reduce this form of interference by fitting suppressors in the high-tension leads to distributor and plugs, but even when this is done there is a residuum of interference which can be objectionable near a very busy highway, or in areas of weak field-strength. For this reason it is common practice to fit a "noise limiter" in the sound channel of the television receiver to reduce this form of interference to negligible proportions.

Neither suppression in the car nor limiting in the receiver is a completely satisfactory solution alone, but where both are employed no audible interference is noticeable. Even in a busy area and with unsuppressed vehicles a compound form of limiter will yield appreciable entertainment value where without it the programme would be completely masked by ignition interference.

Two basic types of limiter are commonly used, the "Series" type and the "Shunt." Where moderate values of suppression are judged sufficient the series circuit is employed, but where a very low signal/noise ratio exists, a combination of the two called the "Compound" limiter gives superior results. It is the purpose of this article to give data enabling such circuits to be designed around the germanium rectifier.

A major portion of the energy within the television frequency band which is radiated from a car is in the form of short, high-amplitude, pulses of radio-frequency energy. For a given energy content, the higher the amplitude and the shorter the duration of this pulse, the more effectively will a limiter reduce it relative to the wanted signal. The modulation envelope of such a pulse contains large components of frequencies greatly exceeding those carrying the audio signal, and unless the sound channel of the receiver is capable of transmitting this envelope without appreciable distortion from aerial to limiter, even the most efficient forms of limiter cannot give good performance. For this reason it is usual to design the sound channel to pass all modulation frequencies up to at least 100 kc/s, and to provide amplifying stages which will not produce inter-modulation of the audio components by the interference pulses. Since these high modulation frequencies must be passed right up to the limiter itself, it is advisable to fit the limiter immediately following the second-detector load.

Peak Limiting

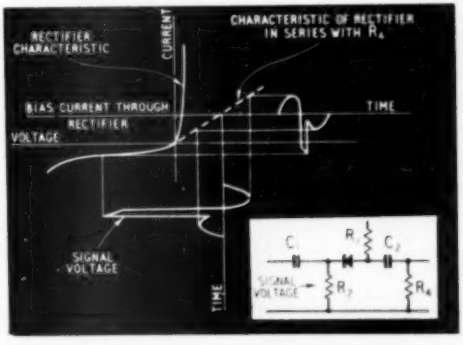
When an interference pulse greatly exceeds the maximum value of signal voltage, its nuisance effect may be reduced by limiting its value by means of a resistor and rectifier in series. The action of this circuit is shown in Fig. 1. The two resistors R_1 and R_2 are so high in value relative to R_4 that their shunting effect is negligible. The biasing current for the rectifier, which is drawn through R_1 and R_2, should be so high in value that it is slightly in excess of half the peak-to-peak value of maximum signal current which will flow through R_4, thus ensuring that the audio-frequency signal will never be "clipped" by excursions over the reverse characteristic of the rectifier. Although this circuit as described gives a fair reduction of interference, it still leaves an annoying level because pulses must necessarily exceed the audio signal in amplitude. A further improvement may be effected by taking advantage of the difference in frequency between the major components of audio signal and interference.

Frequency Discrimination

If a variable-frequency signal be applied across a resistor and capacitor in series, the voltage across the capacitor will decrease as frequency increases, over the frequency range where capacitor impedance is comparable with or lower than that of the resistor, but it will remain approximately constant over that portion of the range where capacitor impedance is much higher than that of the resistor. Thus if a value of capacitance be chosen which will not attenuate the audio-frequency spectrum, but which will attenuate the interference spectrum, the voltage output

* General Electric Company.

Fig. 1. Pulse limiting by rectifier. The circuit is that of the widely used series type of limiter.



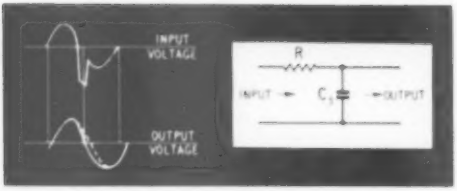
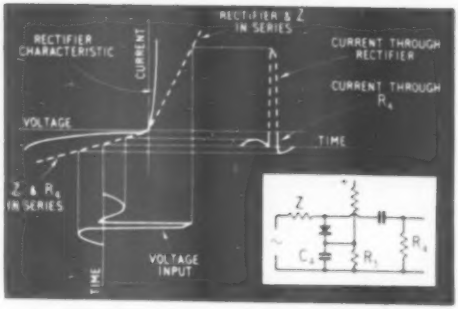


Fig. 2. Interference reduction by frequency discrimination.



Right: Fig. 3. Operation of the shunt limiter.

from the circuit of Fig. 1 may be still further improved as shown in Fig. 2. The dotted portion of output voltage indicates the waveform in the absence of the interference pulse, and it is evident that a further reduction has been accomplished.

In actual practice, an additional resistor "R" is not employed but the reverse resistance of the rectifier is made to fulfill this function, and C_3 is shunted across the output circuit following the rectifier in a series limiter. When so used, a much greater ratio of resistor impedance to capacitor impedance over the interference spectrum may be employed, since during conduction of signal current the effective value of R will be that of the second detector load, while during conduction of an interference pulse R is equal to the much higher value of the rectifier reverse impedance.

The Shunt Limiter

Although the rectifier used in the series limiter serves to "clip" the pulses to an amplitude only a little in excess of the peak audio signal, the rectifier, whatever its type, will have a finite reverse impedance, either resistive or capacitive; hence the clipping will not be perfect and an advantage is obtained by including an additional shunt limiter as a clipping stage ahead of the series limiter. When this is done, the rectifier in the series limiter ceases to "clip," but it is still advantageous to employ a rectifier in place of a resistor in series with C_3 because of its large increase of resistance for negative-going pulses of moderate amplitude.

The operation of a shunt limiter is shown diagrammatically in Fig. 3. The effective source impedance (due to r.f. drive, second detector, and load) is represented by Z, and the rectifier is biased by current through R_1 to operate entirely over the reverse characteristic for all audio signals. The capacitor C_4 has such a value that negligible change of biasing voltage occurs due to interference pulses. It will be seen that the effect of this limiting circuit is to clip the interference pulses fed into the next stage to an amplitude a little greater than that of the maximum audio-frequency signal to be handled. While the impedance Z is mainly resistive, this is the maximum improvement which can be obtained from the shunt limiter, but if an inductance (used as a carrier filter choke) be inserted in series with Z, then a measure of frequency discrimination will be obtained which reduces still further the pulse amplitude. The measure of improvement obtained, however, will never be so great as that due to the series limiter, and for this reason, if only a single limiter is to be used it is usual to employ the series form.

The Compound Limiter

When the two circuits are combined to form a compound limiter as shown in Fig. 4 a very efficient combination results. The component values are restricted by operating conditions, and the final choice must be a compromise between conflicting requirements. R_5 is a rudimentary carrier-elimination filter, working in conjunction with the input capacitance of the audio amplifier. It is inadvisable to allow much more than 0.5-MΩ grid-cathode resistance because of "backlash" current to the grid, and a suitable choice would be 0.1 MΩ for R_5 and 0.47 MΩ for R_4. R_4 may be a potentiometer with R_5 connected to the slider to give volume control. The audio-feed capacitors C_1 and C_2 should present a negligible impedance to the lowest audio frequencies relative to R_4, and for a high-fidelity amplifier this will necessitate a value as high as 0.1 μF for each of them, giving a 0.5-db fall at 50 c/s. A smaller capacitance may be used if the decrease in low-frequency response can be tolerated, 0.01 μF resulting in 4.2 db loss at 50 c/s. The values of R_1 and R_2 should be approximately equal to give minimum shunting of R_4, and the total resistance must be chosen to give the desired value of biasing current through D_2. The value of this current depends entirely upon the maximum level at which the channel will operate, and if V_a is the peak audio-frequency voltage to be handled by the audio amplifier, a useful guide to value of current I, is given by the equation:—

$$I = \frac{1.1\,V_a\,(R_2 + R_4)}{R_2\,R_4} \qquad \text{(1a)}$$

If $R_1 = R_2$ and V_a = h.t. voltage.

$$R_2 = R_4\left(\frac{V_a}{2.2V_a} - 1\right) \qquad \text{(1b)}$$

The value of second-detector load R_L will be circumscribed by the design of the input transformer and by the bandwidth to be passed. A further limitation on its maximum value exists however, due to the shunting effect of R_4. If the effective audio-frequency impedance of the complete load is considerably smaller than the impedance to direct current, distortion of deeply modulated signals occurs. The actual value chosen is a compromise, but it is suggested that for high-fidelity systems the reduction should be less than 10% and where some distortion can be tolerated, less than 30%. Assuming again, that

R_1 and R_2 are approximately equal in value, these two limits result in the following equations :—

High Fidelity :—

$$R_L < \frac{0.1\ R_2\ R_4}{R_2 + 2\ R_4} \quad .. \quad .. \quad .. \quad (2a)$$

Moderate Fidelity :—

$$R_L < \frac{0.4\ R_2\ R_4}{R_2 + 2\ R_4} \quad .. \quad .. \quad .. \quad (2b)$$

Although the value of C_L is strictly a problem related to the design of the detector circuit, it is included here since efficient noise limiting depends upon the frequency response of this circuit. The time constant of R_L and C_L should be in the neighbourhood of 2.5 microseconds, which gives for the magnitude of the capacitance :—

$$C_L = \frac{2.5 \times 10^6}{R_L}\ \text{pF} \quad .. \quad .. \quad .. \quad (3)$$

For the suppression of pulses, C_3 should be as large as possible, but to preserve audio-frequency response, as small as possible. As C_3 increases in value, the attenuation of the higher audio frequencies increases due to its "shunting" of R_L. As a compromise, for high-fidelity systems, it is suggested that its reactance at 10 kc/s should equal the resistance of R_L, but that where noise is extremely bad and field strength low, a sacrifice of top-notes be made by increasing C_3 until it equals R_L at 3 kc/s. The value under these two conditions may be calculated from the equations:—

High Fidelity :—

$$C_3 = \frac{10^6}{2\pi R_L}\ \text{pF} \quad .. \quad .. \quad .. \quad .. \quad (4a)$$

Low Fidelity :—

$$C_3 = \frac{10^6}{6\pi R_L}\ \text{pF} \quad .. \quad .. \quad .. \quad .. \quad (4b)$$

In deriving equation (1a) the value of R_3 has been ignored. This was possible because over the practicable range of values which may be used in a television receiver, its inclusion would have a negligible effect on the value of R_2 as calculated from equation (1b). The function of R_3 is to provide a biasing voltage for D_2 which shall be slightly in excess of the peak audio signal to be handled. In this case, to avoid distortion by working on the "bend" of the rectifier characteristic, it is suggested that the biasing voltage be 1.3 times the maximum audio peak, and using the relationship in equation (1a) the following law is obtained :—

$$R_3 = \frac{1.2\ R_2\ R_4}{R_2 + R_4} \quad .. \quad .. \quad .. \quad .. \quad (5)$$

The value of C_4 is not critical providing it gives a time constant together with R_3 which is long relative to the duration of an interference pulse. A value of 0.05 μF is adequate for this purpose.

For the suppression of pulses a large inductance is desirable for L_1, but for good high-frequency response of the sound channel a low value is essential. This value also will be a compromise between the conflicting requirements of fidelity and suppression, and it is suggested that its impedance at 50 kc/s should be made equal to that of R_L, which gives as a relationship :—

$$L_1 = \frac{10 R_L}{\pi}\ \mu\text{H} \quad .. \quad .. \quad .. \quad .. \quad (6)$$

Some disturbance of the audio response occurs due to the effect of L_1 and C_3 in series, but resonance only occurs above the band which may be received. What is more serious is that this resonance, which is ineffective in the case of "impulsive" noise due to the "cut-off" effect of D_2, becomes serious in the case of some other forms of interference. The best advice is to try the circuit in a particular location both with and without L_1 in circuit, and to choose the condition which gives greatest improvement on the type of interference in that neighbourhood.

For the guidance of those who may wish to construct the complete circuit and fit it as a unit into an existing receiver, suitable component values are given in Table 1.

Overall Performance

Due to variation in the modulation envelope of received noise, there is little point in attempting to calculate attenuation for certain theoretical forms. Such calculations are only of service to compare the performance of different rectifiers in a given circuit, but for the comparison of different circuit behaviours a noise generator and measuring equipment are desirable.

Extensive measurements have been made on the audio-frequency harmonic distortion introduced by the circuits described, and it has been found negligible (less than 1%) in the circuits here described when suitable rectifiers are used. Two types which have been used with success are the GEX.34 as series

Fig. 4. Circuit of sound-channel rectifier and compound limiter.

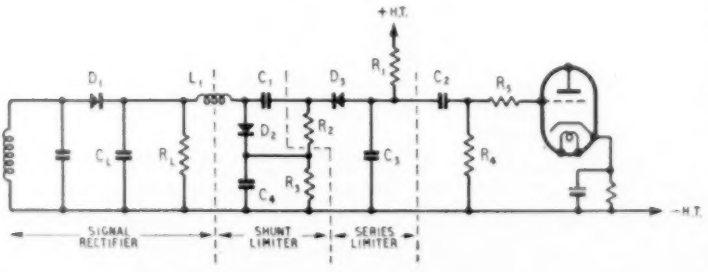


TABLE 1

Typical Component values for circuit shown in Fig. 4.

R_1, R_2	= 4.7 MΩ
R_3, R_4	= 0.47 MΩ
R_5	= 0.1 MΩ
R_L	= 68 kΩ
L_1	= 200 mH
D_1, D_3	= GEX.34
D_2	= GEX.03
C_1, C_2	= 0.1 μF
C_3	= 300 pF
C_4	= 0.05 μF
C_L	= 47 pF

limiter, and the GEX.03 as shunt limiter. In each case, for the approximate calculation of performance, the forward characteristic may be considered a linear slope of 100 ohms cutting the voltage axis at +0.3 volt, and the reverse characteristic as a linear slope of 350,000 ohms passing through the origin. The small portion (0 to +0.3V) not so described is a curve passing through the origin and "running into" the linear forward characteristic. This characteristic is only an approximation to a more complicated form, but it will be found adequate for assessing the operating conditions and performance.

When choosing a rectifier for the series-limiter circuit great care must be taken to obtain a low shunt capacitance, since a high capacitance will vitiate the frequency discrimination required for successful operation. In this connection the germanium rectifier has the lowest self-capacitance (less than 1.0 pF) of any available component, and providing care is taken when "wiring up" the circuit to minimize circuit strays, full advantage will be taken of this feature. For the shunt limiter, on the other hand, a very low forward impedance is the essential characteristic, and in this feature also the germanium rectifier is unequalled among the various components available for the function.

Compound limiters similar to the one described have been tried out in many fringe areas, and found adequate in performance, even when the aerial has to be directed along a main highway to "view" the transmitting station. It may be taken as a general guide that where regular entertainment value may be obtained from the picture, the compound limiter will be adequate to give acceptable sound reception. The only exception to this rule is in areas where interference other than that from ignition systems is the major limitation to reception; unless the interference is mainly of "impulsive" type, this form of limiter will not be found of great value, but fortunately for most viewers their interference will be found such that a compound limiter will render it inaudible.

Acknowledgments

Acknowledgement must be made to the General Electric Company Limited who have allowed information gained from work in their laboratories to be used in the preparation of this article, and to several colleagues whose labours have provided the data for it.

Book on Interference Suppression

MOST radio people tend to regard interference suppression as something of a mystical art, only to be practised by certain individuals gifted with a special kind of occult understanding. This is partly the fault of the scant literature on the subject, which in general amounts to little more than a collection of cookery-book recipes, with nothing in the way of consistent explanation to hold them together—perhaps because the authors don't want to give away too many trade secrets! In such circumstances, then, it is very encouraging to see a new approach to the subject—a book whose main object is to make clear the underlying principles of suppression technique, so providing the reader with a good basis from which to tackle the particular problems that come his way.

That is not to say "Radio Interference Suppression," just published for *Wireless World*, is a vague or academic book. Far from it. The author, G. L. Stephens, is an engineer with extensive experience in this field, and he writes for practical men. Thus, after explaining the origins of interference and principles of suppression, he goes on to give many practical examples of the technique. Some of the interfering appliances he discusses are engine ignition systems, switches, thermostats and contactors, electric motors and generators, rotary converters, lifts, neon signs, fluorescent and other types of discharge lighting, trams, trolleybuses and electric trains, radio-frequency heaters, welding apparatus, oil-fired boilers, television receivers, spectrographic equipment, and valve rectifiers.

Throughout the book particular attention has been paid to the problem of interference on television frequencies. Special attention is also given to suppression methods on motor vehicles and on board ship. Other chapters deal with the design and choice of suppressor components, methods of locating the source of interference, and suppression at the receiver itself. Reference data given in the appendices includes some useful information on screened rooms.

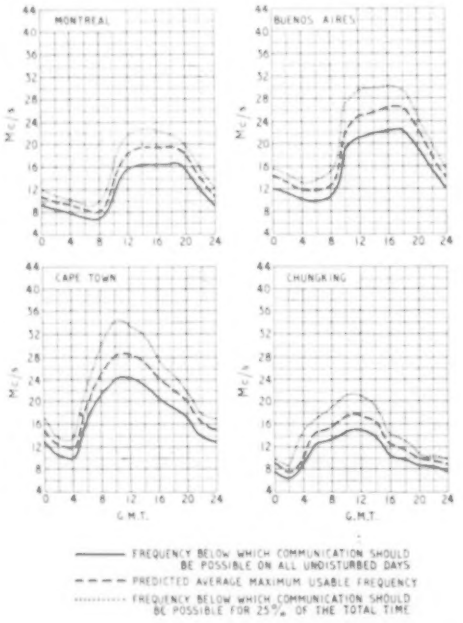
"Radio Interference Suppression" is published for *Wireless World* by Iliffe & Sons Ltd. It can be obtained from any bookseller, price 10s 6d, or direct from our Publishers at 10s 11d by post.

Short-wave Conditions

Predictions for September

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during September.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.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6AQ5 6X4
(6X4 permits operation from common heater winding.)

AC/DC RECEIVERS
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VIBRATOR & CAR RADIO RECEIVERS
Type 6AK6 economy output Valve with heater consumption of 0.15 amp. at 6.3v may be used in place of type 6AQ5.

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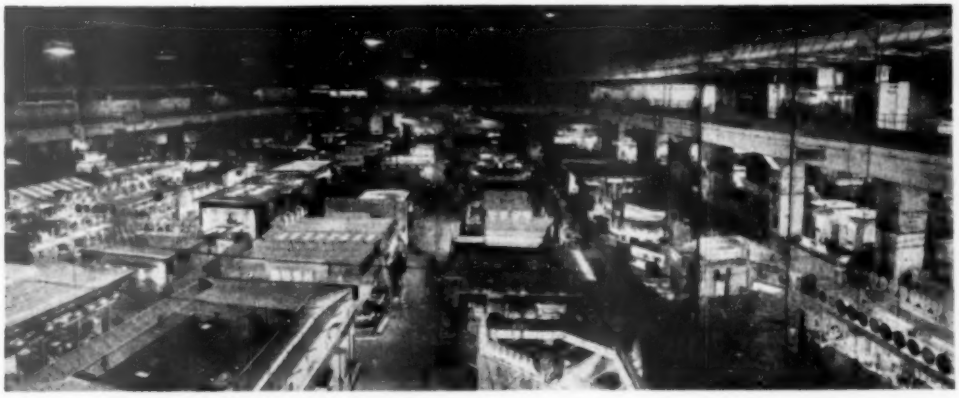


19th National Radio Exhibition

Classified Guide to the Principal Classes of Exhibits

TO-DAY, 26th August, the 19th National Radio Exhibition at Earls Court is being viewed by specially invited guests and members of the public prepared to pay 5s. To-morrow (27th August) it will be officially opened at 12 noon by Lord Burghley, president of the Radio Industry Council who are sponsoring the Show which continues until 6th September.

The price of admission on all days, except 26th August, is to be 2s 6d for adults and 1s for children. Parties of from 25 to 50 are to be admitted at 2s each and parties of 50 or more at 1s 9d each.

Of the 108 exhibitors, 32 are manufacturers of broadcast and television receivers and in the Hall of Television 29 manufacturers are demonstrating 80 receivers. In addition, as will be seen from the list of standholders, a number of manufacturers have their own demonstration rooms.

Believing that the primary function of a guide is to present information in an easily assimilated form, we have again prepared our pre-view as classified and tabulated lists of the principal exhibits. The exhibitors are listed alphabetically under their trade names or abridged names by which they are best known and also numerically by stand numbers. This, we think, enables the makers of any particular class or item of equipment to be found and, with the aid of the plan, readily located in the exhibition.

Not all the exhibits readily fall into the categories chosen for our tabulated lists, among them being printed circuits (Hunt), radio relay receivers (E.M.I.) and electronic musical instruments (Selmer). Also there are not sufficient examples of the heavier side of radio—transmitters and navigational gear—to justify a section, but mention should be made of the v.h.f. mobile gear shown by G.E.C. and television transmitters exhibited by Pye.

"How it works" is the keynote of the Show and ingenious devices have been utilized to this end by some of the manufacturers. The R.I.C., too, has made use of some of the wide open spaces (which last year called forth the criticism that they created a sepulchral gloom) to house special exhibits of electronic apparatus in use. These electronic "side shows" include demonstrations of underwater television, radio-frequency heating and an electronic stencil cutter for duplicating purposes. The process employed in the stencil cutter is similar in principle to that used for the radio transmission of photographs; the scanning rate is 500 lines to an inch.

At the present time considerable stress is being laid on the demands of the Forces on the radio industry and each of the three Services is showing something of the part played by radio in communications, navigation, defence and attack. A replica of the radar and wireless office in a submarine is included on the Navy's stand, where ratings of the Electrical Branch (which is responsible for the maintenance of all radio, radar and electrical equipment in the Fleet) will be seen repairing equipment in an electronics maintenance room similar to that in a modern battleship. The R.N.V.(W.)R. is also represented on the stand.

The two main users of radio and electronic gear in the Army—the Royal Corps of Signals and the Royal Electrical and Mechanical Engineers—are sharing the Army's stand. The centrepiece of the R.E.M.E. section is a radio-guided missile. Gun-laying radar is shown in use and laid out bread-board fashion for instructing trainees in circuitry.

To demonstrate the use of radio for the control of aircraft the R.A.F. is staging a flying display of models made by members of the R.A.F. Model Aircraft Association. The aircraft, which are electrically driven, fly in a circuit (they are tethered to a central post by a thin cable carrying the power supply) and the retraction of the undercarriage, opening of bomb doors, etc., is controlled by radio.

All R.A.F. apprentices who enter for the radio and radar trades are trained at No. 6 Radio School, Cranwell and some of the 1,000 at present undergoing training, preparatory to becoming junior technicians in the trades of air or ground radio fitters, are to be seen

demonstrating some of the phases in the three-year course.

The central feature of the B.B.C.'s contribution to the Exhibition is, of course, the studio, which is about twice the size of last year's, incorporating an auditorium with seating for nearly 1,000. The studio is equipped with a mobile television control room, a three-camera channel unit, and a 3-ton motor-driven camera crane. For the sound transmissions from the studio an echo room has been provided with all the paraphernalia for sound effects.

During the show (on 2nd September) the first annual dealers' conference, organized by the British Radio Equipment Manufacturers' Association (a constituent body of the R.I.C.) will be held and will cover such subjects as maintenance schemes for receivers and sales promotion. The Radio and Television Retailers' Association has presented season tickets to each of its members.

For the first time a technical training display is included in the Show to back up the efforts of both the industry and the educational authorities to make good the shortage of technicians in the industry. A number of educational bodies have co-operated with the R.I.C. in presenting demonstrations, which should increase technical interest in the show and at the same time encourage some visitors to seek further information on the possibilities of technical careers in the industry, about which a leaflet has been prepared. Among the colleges and institutions providing demonstrations are Imperial College, Norwood Technical College, Northampton Polytechnic, E.M.I. Institutes, Marconi College and College of Aeronautics.

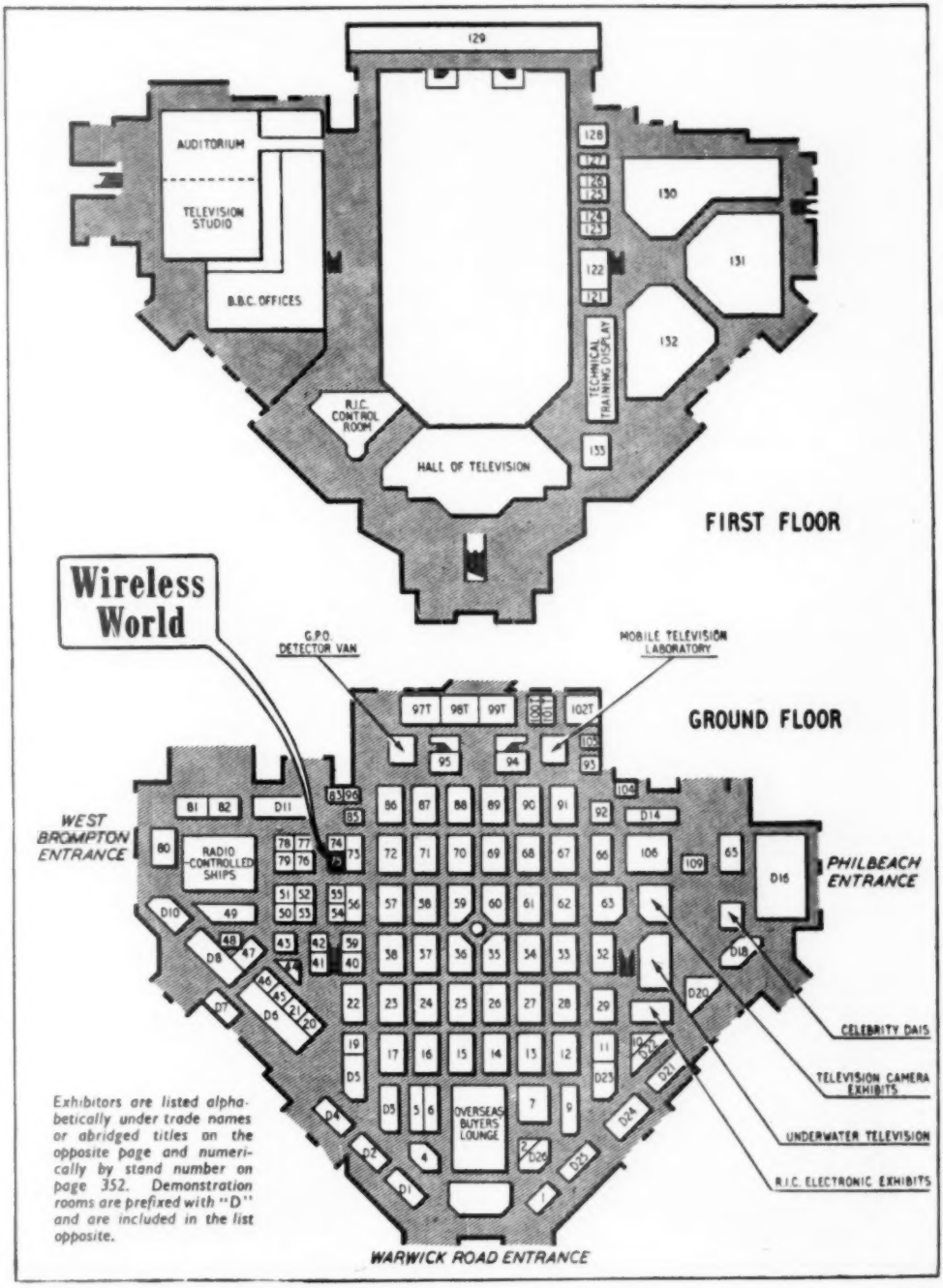
Arrangements for the relaying of both sound and vision programmes to the Hall of Television and the stands and demonstration rooms are similar to last year's. The television waveform, which conforms to standard B.B.C. practice, will be piped on channel 4 (61.75 and 58.25 Mc/s) and each outlet in the show feeds one receiver with a signal level of 1 mV ± 3db into 70 ohms unbalanced. The distribution centre for both the sound and vision transmissions is the Control Room on the first floor, which can be seen by visitors through glass windows. The television programme is virtually continuous throughout each day, being made up of normal B.B.C. transmissions (which are radiated from Alexandra Palace by radio on a special channel), a 35-mm film scanner in the Control Room, shows in the exhibition studio and features from the celebrity dais on the ground floor.

An information bureau at which details of the services offered by the various sections of the Board of Trade and the Patent Office is provided at Stand 2. A feature of the Television Society's stand is the various units designed by members for incorporation in the Society's television transmitter (G3CTS/T) which it is hoped to put into service shortly. The Electrical Trades Union has an information bureau at which particulars of the union's activities in the radio and electrical industries may be obtained.

ALPHABETICAL LIST OF EXHIBITORS AND GUIDE TO STANDS

Name	Stand
A.R.B.M.	86
Ace	66
Aerialite	50
Alba (Balcombe)	35
Amplion	54
Antiference	22
Army	132
Avo (Automatic Coil Winder)	46
B.B.C.	129
Baird	33
Barclays Bank	51
Belling-Lee	25
Bernards	127
Board of Trade	2
Brimar (S.T.C.)	6
"British Radio & Television"	44
British Railways	4
Brown Brothers	97T
Bulgin	1
Bush	16(D3)*
Champion	133
Collaro	91
Cossor	37(D25)
Decca Records	61(D2)
Defiant (Co-op)	12(D18)
Dubilier	79
Dynatron	40
E.M.I.	68
E.T.U.	125
Econasign	21
Eddystone (Stratton)	124
Ediswan	62(D1)
Eelex (Eastick)	102T
Ekco	2&(D8, D10)
"Electrical & Radio Trading"	74
Elpico (Lec)	77
English Electric	67
Ever Ready	57
Exide & Drydex (Chloride)	94
Ferguson	88(D23, D24)
Ferranti	14(D26)
G.E.C.	26, 78 (D6)
Garrard	92
Goodmans	41(D7)
H.M.V. (Gramophone Co.)	89, 109(D16)
Hobday	99T
Hunt	56
Imhof	19
Invicta	71
J.B. Cabinets	9
J.G. Publications	43
K.B.	28
Kerry's	98T
L.E.S.	101T
Linguaphone	96
Livingston Laboratories	93
Lloyds Bank	81
McCarthy (Felgate)	7
McMichael	69
Marconiphone	87(D14)
Masteradio	63
Mullard	17(D5)
Multicore	32
Murphy	15(D4)
National Provincial Bank	82
Navy	130
Pamphonic	85
Peto Scott	23
Petter	100T
Philco	38
Philips	59, 60 (D11)
Pilot	58
Plessey	80
Portogram	20
"Practical Wireless" and "Practical Television"	52
Prowse	104
Pye	36 (D21)
R.A.F.	131
R.G.D.	29
Regentone	13
Roberts	39
Rola-Celestion	73
Sculptured Sound (Sali)	121
Selmer	10(D22)
Sentercel (S.T.C.)	55
Simon	47
Skarsten	48
Sobell	34
"Star"	65
Stella	27
T.C.C.	72
Taylor	53
Telcon	42
Telequipment	83
Telerection	11
Television Society	126
Turnidge	123
Ultra	70(D20)
Valradio	122
Vidor	90
W.B. (Whiteley)	95
Waveforms	103
Westinghouse	49
Westminster Bank	5
White-Ibbotson	128
"Wireless Trader"	45
"Wireless World" and "Wireless Engineer"	75
Wolsey	76

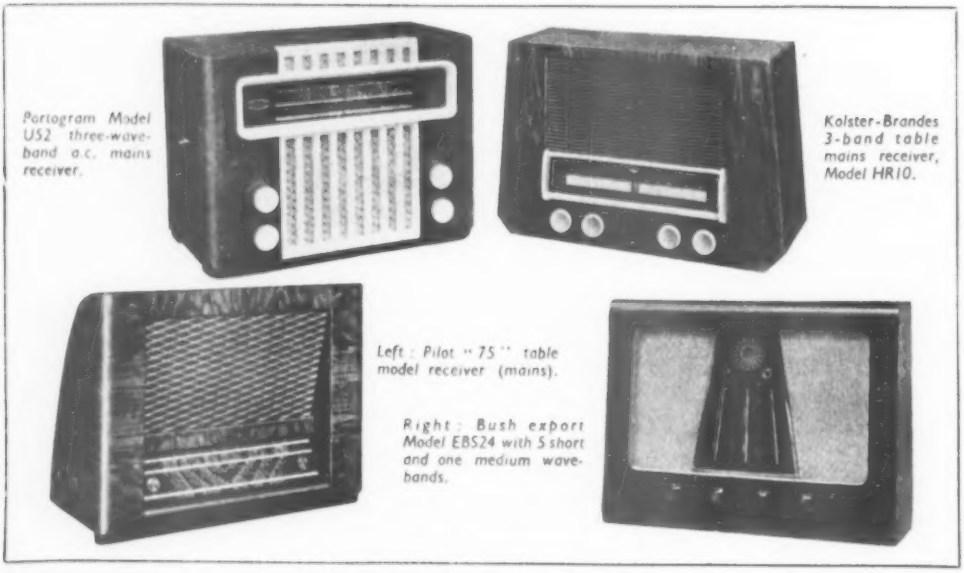
*Demonstration rooms and offices prefixed with "D"



Exhibitors are listed alphabetically under trade names or abridged titles on the opposite page and numerically by stand number on page 352. Demonstration rooms are prefixed with "D" and are included in the list opposite.

RECEIVERS : Broadcast, Television, Communications and Special-purpose

FIRM	(Stand)	Broadcast								Television					V.H.F., domestic	V.H.F., communication	Communications	Car
		Mains	Battery	Mains battery	Portable	Personal portable	Radio-gramophone	Chassis	Kits	Direct-viewing	Projection	Television-broadcast	Chassis	Kits				
Aiba	(35)	●	●	●	●	—	●	—	—	●	—	●	—	—	—	—	—	—
Baird	(33)	●	—	—	—	—	●	—	—	●	●	—	—	—	—	—	—	—
Bush	(16)	●	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Champion	(133)	●	—	●	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Cossor	(37)	●	—	●	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Decca	(61)	—	—	—	—	—	●	—	—	●	●	●	—	—	—	—	—	—
Defiant	(12)	●	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Dynatron	(40)	●	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Eddystone	(124)	●	●	—	—	—	—	●	—	●	—	—	—	—	—	●	●	—
Ekco	(24)	●	—	●	●	—	●	—	—	●	—	—	—	—	—	—	—	●
Elpico	(77)	—	—	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—
English Electric	(67)	—	—	—	—	—	—	—	—	●	—	—	●	—	—	—	—	—
Ever Ready	(57)	—	●	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—
Ferguson	(88)	●	—	●	●	—	●	—	—	●	—	—	—	—	—	—	—	—
Ferranti	(14)	●	●	●	●	—	●	—	—	●	●	—	—	—	—	—	—	—
G.E.C.	(26, 78)	●	●	●	●	—	●	—	—	●	—	●	—	—	—	—	—	—
H.M.V.	(89, 109)	●	—	—	—	—	●	—	—	●	—	●	—	—	—	—	—	—
Invicta	(71)	●	—	●	●	—	●	—	—	●	—	—	—	—	—	—	—	—
K.B.	(28)	●	●	●	●	●	●	—	—	●	—	—	—	—	—	—	—	—
McCarthy	(7)	●	—	●	●	—	●	—	—	●	—	—	—	—	●	—	—	—
McMichael	(69)	●	—	●	●	—	●	—	—	●	—	●	—	—	—	—	—	—
Marconiphone	(87)	●	—	●	●	—	●	—	—	●	—	●	—	—	—	—	—	—
Masteradio	(63)	●	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	●
Murphy	(15)	●	—	●	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Pamphonic	(85)	—	—	—	—	—	●	—	—	●	—	●	—	—	—	—	—	—
Peto Scott	(23)	—	—	—	—	—	●	—	—	●	●	—	—	—	—	—	—	—
Potter	(100T)	—	—	—	—	—	—	—	—	●	—	—	—	●	—	—	—	—
Philco	(38)	●	—	—	●	—	●	—	—	●	—	—	—	—	—	—	—	—
Philips	(59, 60)	●	—	—	—	—	●	—	—	●	●	—	—	—	—	—	—	—
Pilot	(58)	●	●	●	●	—	●	—	—	●	—	—	—	—	—	—	—	—
Portogram	(20)	●	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Pye	(36)	●	●	●	●	●	●	—	—	●	—	—	—	—	—	—	—	●
Regentone	(13)	●	●	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—
R.G.D.	(29)	—	—	—	—	—	●	—	—	●	●	—	—	—	—	—	—	—
Roberts	(39)	—	●	●	●	—	—	—	—	●	—	—	—	—	—	—	—	—
Sculptured Sound	(121)	●	—	—	—	—	●	—	—	●	●	●	—	—	—	—	—	—
Sobell	(34)	●	—	—	—	—	●	—	—	●	—	—	—	—	—	—	—	—
Stella	(27)	●	—	—	—	—	●	—	—	●	●	—	—	—	—	—	—	—
Ultra	(70)	●	—	●	—	—	●	—	—	●	—	●	—	—	—	—	—	—
Valradio	(122)	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—	—	—
Vidor	(90)	●	●	●	●	—	—	—	—	●	●	—	—	—	—	—	—	—
W.B.	(95)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—
White-Ibbotson	(128)	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—



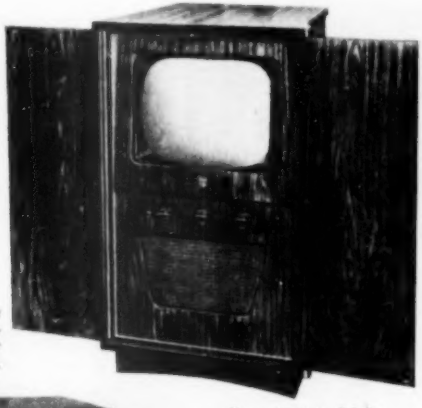
Portogram Model U52 three-waveband a.c. mains receiver.

Kolster-Brandes 3-band table mains receiver, Model HR10.

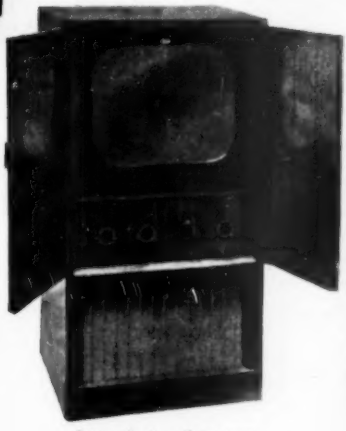
Left : Pilot "75" table model receiver (mains).

Right : Bush export Model EBS24 with 5 short and one medium wavebands.

Left: Dynatron "Fulmer" television receiver with 17-in tube.

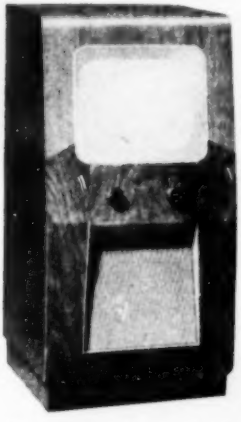


Ekco Model TC171 16-in tube television receiver with grey filter and spot wobble.



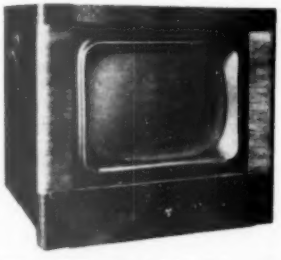
Peto Scott flat-screen projection television receiver, Model TV169.

Valradio large screen projection television receiver Type V3C giving picture 3 x 4ft.



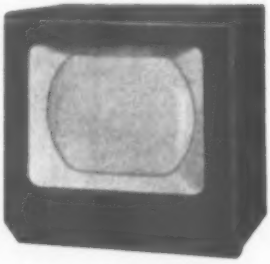
Marconiphone 12-in tube 5-channel television receiver for a.c./d.c. Model VC59DA.

Above: H.M.V. Model 1814 5-channel television receiver.



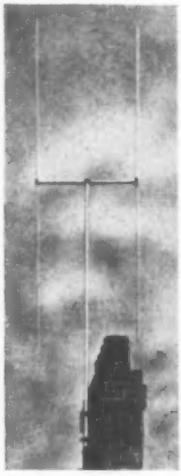
Left: Vidor table model television receiver.

Right: R.G.D. Model 6015T table television receiver with 15-in tube.



Cossor a.c. d.c. television set model 927 with 12-in. tube.

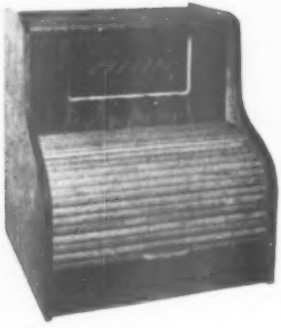
Regentone "Auto 99" table radiogram.



Belling-Lee "Junior H" television aerial on 9-ft. lightweight mast.

Left: McCarthy (Felgate) table radiogram with 3-speed record changer in roll-top compartment.

Ultra 12-in. table television receiver Model V80.



ACCESSORIES : Including Materials, Valves and Non-electronic Rectifiers

FIRM (Stand)	Aerials: Broadcast	Aerials: Television and E.H.F.	Aerials: Anti-interference	Aerials: Car	Aerial accessories	Valves	C.R. tubes	Photocells	Metal rectifiers	Crystal valves	Battery chargers	Batteries	Power units, eliminators	Interference suppressors	Permanent magnets	Magnetic recording tape	Wire and cable	R.F. cable	Insulants	Coil formers	Solder	Television pre-amplifiers	Television optical accessories
A.R.B.M. (86)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Aerialite (50)	●	●	●	●	●	—	—	—	—	—	●	—	—	●	—	—	●	●	—	—	—	—	—
Amplion (54)	●	●	●	●	●	—	—	—	—	—	—	—	●	●	—	—	●	●	—	—	—	—	—
Antiference (22)	●	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	●	●	—	—	—	—	—
Belling-Lee (25)	●	●	●	●	●	—	—	—	—	—	—	—	—	●	—	—	●	●	—	—	—	●	—
Brimar (6)	—	—	—	—	—	●	●	—	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—
Cossor (37)	—	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dubilier (79)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E.M.I. (68)	●	●	●	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	●	—
Eddystone (124)	●	—	—	—	—	—	—	—	—	—	—	—	●	●	—	●	●	●	●	●	●	—	●
Ediswan (62)	—	—	—	—	—	●	●	●	—	●	—	—	●	●	—	—	—	—	—	—	—	—	—
Ekco (24)	—	—	—	—	●	—	—	—	—	—	—	—	—	●	—	—	●	●	●	●	●	●	●
Elpico (77)	●	—	—	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
English Electric (67)	—	—	—	—	—	—	●	—	—	—	—	—	—	●	—	—	●	●	●	●	●	—	●
Ever Ready (57)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Exide (94)	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
G.E.C. (26, 78)	—	—	—	—	—	●	●	●	—	○	—	—	—	—	—	—	—	—	—	—	—	—	—
H.M.V. (89, 109)	—	●	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
McMichael (69)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Marconiphone (87)	—	●	—	—	—	●	●	—	—	—	—	—	—	●	—	—	—	—	—	—	—	●	●
Masteradio (63)	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mullard (17)	—	—	—	—	—	●	●	—	●	—	—	—	—	—	●	—	—	—	—	—	—	●	●
Multicore (32)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sentercel (55)	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—
T.C.C. (72)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Telcon (42)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●	●	—	—	—	—
Telerection (11)	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Valradio (122)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vidor (90)	—	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—
W.B. (95)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	●	—	—
Westinghouse (49)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	●	—	—	—	—	—	—	—	—
Wolsey (76)	●	●	—	—	●	—	—	—	●	●	—	—	—	—	—	—	—	—	—	—	—	●	—

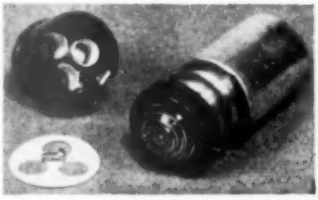
COMPONENTS : Excluding Accessories

FIRM	(Stand)	Capacitors, fixed	Capacitors, variable	Trimmers	Resistors, fixed	Resistors, variable	Resistors, non-ohmic	Switches	Coils, R.F.	Coil Unit sub-assemblies	Transformers, mains	Transformers, audio	Chokes	Plugs, sockets, connectors, adapters	Chassis fittings (valveholders, etc.)	Cabinets, racks, chassis	Dials, drives, knobs	Vibrators	Scanning components	Focus and ion-trap magnets
Amplion	(54)	—	—	—	—	●	—	—	●	●	—	—	—	—	—	—	—	—	—	—
Belling-Lee	(25)	—	—	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—
Brimar	(6)	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—
Bulgin	(1)	—	●	●	●	●	—	●	—	—	—	●	●	●	●	●	●	—	—	—
Dubilier	(79)	●	●	●	●	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dynatron	(40)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E.M.I.	(68)	—	—	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Eddystone	(124)	—	●	—	—	—	—	—	●	—	—	—	—	—	—	—	—	—	—	—
Ediswan	(62)	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Elpico	(77)	—	●	—	●	—	—	●	●	●	●	●	●	●	●	●	●	●	—	—
Goodmans	(41)	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—	—	—	—
Hunt	(56)	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Imhof	(19)	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●	—	—	—	—
J.B. Cabinets	(9)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—
Mullard	(17)	—	—	●	—	—	●	—	—	—	—	●	—	—	—	●	—	—	—	●
Rola-Celestion	(73)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sculptured Sound	(121)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—
T.C.C.	(72)	●	—	●	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Telcon	(42)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	—	—	—	—
Valradio	(122)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—
W.B.	(95)	—	—	—	—	—	—	—	●	—	●	●	●	●	●	●	●	—	●	●
Wolsey	(76)	—	—	—	—	—	—	—	—	—	—	—	—	●	—	—	●	—	—	—

One of the new Westinghouse sealed E.H.T. rectifiers.

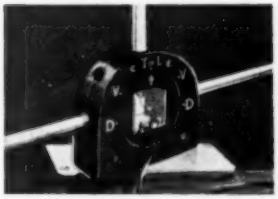
Mullard rectangular television tube Type MW36-22.

New "BR" 8-mfds Dubilier Drilitic (lower) compared in size with earlier type.

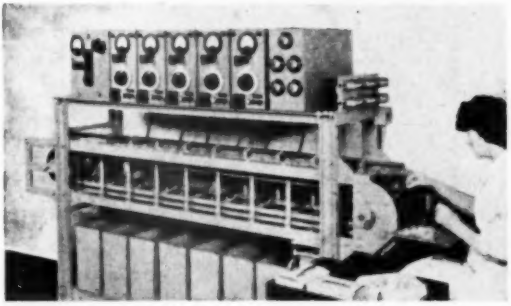


Bulgin 3-colour panel-type signal lamp.

Right: Wolsey indoor television aerial unit with switching for different arrangements.



Selection of Aerialite car radio aerials.



Automatic capacitor testing and grading machine developed by T.C.C.

TEST AND MEASURING GEAR : Including Signal Sources

FIRM (Stand)	Single-range pointer meters	Multi-range meters	Bridges and accessories	Valve voltmeters	Test sets	Signal sources	Television signal sources	Oscilloscopes	Wavemeters
Amplion (54)	—	●	—	—	—	—	—	—	—
Avo (46)	—	●	●	●	●	●	●	—	—
Cossor (37)	—	—	—	—	—	—	●	●	—
E.M.I. (68)	—	—	●	—	●	●	●	●	—
Eddystone (124)	—	—	—	—	—	—	—	—	●
English Electric (67)	—	—	—	—	—	●	—	—	—
Livingston Labs. (93)	●	●	●	●	●	●	●	●	—
Taylor (53)	●	●	—	●	●	●	●	—	—
Telequipment (83)	—	—	—	—	—	—	●	●	—
W.B. (95)	—	—	—	—	●	—	—	—	—
Waveforms (103)	●	—	—	—	●	●	●	—	—

Eddystone Model 680X communications receiver.

Murphy 12-in Model V200A television receiver with interchangeable r.f. unit.

Baird "Table-Fifteen" television receiver.

Decca large screen (3 x 4ft) projection television receiver.

SCIENTIFIC, INDUSTRIAL AND MEDICAL APPARATUS

FIRM (Stand)	Control devices	Counters	Radiation monitors	Medical apparatus	Hearing aids
Dynatron (40)	—	●	●	—	—
Ediswan (62)	—	—	—	●	—
K.B. (28)	—	—	—	—	●
Westinghouse (49)	●	—	—	—	—

SOUND REPRODUCING EQUIPMENT : Audio Amplifiers and Electro-Acoustic Apparatus

FIRM (Stand)	Microphones	Pickups	Amplifiers	Loudspeakers	Gramophone motors	Record changers	Record players	Electric gramophones	Disc recorders	Tape recorders
Amplion (54)	—	—	—	D	—	—	●	—	—	●
Baird (33)	—	—	—	—	—	—	—	—	—	—
Collaro (91)	—	—	●	—	●	—	●	●	—	—
Decca (61)	—	●	●	D	●	—	●	●	—	—
E.M.I. (68)	●	●	●	D,R	—	—	●	—	●	●
Ediswan (62)	—	●	—	—	—	●	—	—	—	—
Elpico (77)	—	—	●	—	—	—	●	—	—	—
G.E.C. (26 78)	●	—	●	R	—	●	—	—	—	—
Garrard (92)	—	●	—	—	●	●	●	—	—	—
H.M.V. (89, 109)	—	—	—	—	—	●	●	●	—	—
K.B. (28)	—	—	—	—	—	—	—	—	—	—
Pamphonic (85)	●	—	●	D,R	—	●	●	—	—	●
Petter (100T)	—	—	—	—	—	—	●	—	—	—
Portogram (28)	—	—	●	D	—	—	●	—	—	—
Rola-Celestion (73)	—	—	—	D,R	—	—	—	—	—	●
Sculptured Sound (121)	—	—	—	D,R	—	—	—	—	—	—
Simon (47)	—	—	—	—	—	—	—	—	●	●
W.B. (95)	●	—	●	D	—	—	—	—	—	—
Westinghouse (49)	—	—	—	—	—	—	—	—	—	●

D, domestic loudspeakers ; R, sound reinforcement loudspeakers.

Telequipment television waveform generator.

Right : Simon magnetic tape recorder Type TR1A.

Below : Goodmans "Axion 102" 8-in loudspeaker with flux density of 16,000 gauss.

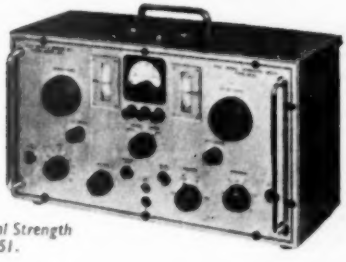
Pamphonic record player with pre-amplifier and tone control.

Collaro Microgram portable electric gramophone.

Latest pattern "Model 8" Avometer.

Right : Taylor insulation tester Type 130A.

Left : Selmer "Clavioline" electronic manual attached to keyboard of piano.



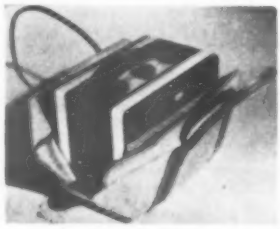
Left : Truvox (Rola) new "Minor" re-entrant horn loudspeaker.

E.M.I. v.h.f. "Signal Strength Meter" Type QD151.

Left: Champion "Coronation" radiogram with 3-speed automatic record changer.

Right: Roberts' new "Junior" all-dry portable.

Below: Alba portable radiogram with spring motor for mains or battery operation.



McMichael "Batman" portable.

G.E.C. Model BC4444 portable receiver.

NUMERICAL LIST OF STANDHOLDERS

1 **A. F. Bulgin & Co.**, Bye-Pass Rd., Barking, Essex.
2 **Board of Trade**, Lacon House, Theobalds Rd., London, W.C.1.
4 **British Railways**, 222, Marylebone Rd., London, N.W.1.
5 **Westminster Bank**, 31, Threadneedle St., London, E.C.2.
6 **Standard Telephones & Cables**, Footscray, Sidcup, Kent.
7 **Folgate Radio**, Frigate House, Shaftesbury St., London, W.6.
9 **J. B. Manufacturing Cabinets Co.**, 86, Palmerston Road, Walthamstow, London, E.17.
10 **Henri Selmer & Co.**, 114/116, Charing Cross Rd., London, W.C.2.
11 **Taylorcraft**, Antenna Works, St. Pauls, Cheltenham, Glos.
12 **Co-operative Wholesale Society**, 99, Leman St., London, E.1.
13 **Recentone Products**, Eastern Avenue, Romford, Essex.
14 **Ferranti**, Hollinwood, Lancs.
15 **Murphy Radio**, Welwyn Garden City, Herts.
16 **Roth Radio**, Power Rd., Chiswick, London, W.4.
17 **Mullard**, Century House, Shaftesbury Avenue, London, W.C.2.
19 **Alfred Imhof**, 112, New Oxford St., London, W.C.1.
20 **Portogram Radio Electrical Industries**, Pool Works, 90, Rye St., London, S.W.6.
21 **Ekco Radio Co.**, 92, Victoria St., London, S.W.1.
22 **Antiference**, 67, Brynmaer St., Marble Arch, London, W.1.
23 **Peto Scott Electrical Instruments**, Addlestone Rd., Weybridge, Surrey.
24 **E.K. Cole**, Ekco Works, Southend-on-Sea, Essex.
25 **Belling & Lee**, Cambridge Arterial Rd., Enfield, Middx.
26 **General Electric Co.**, Magnet House, Kingsway, London, W.C.2.
27 **Stella Radio & Television Co.**, Oxford House, 9/13, Oxford St., London, W.1.
28 **Koister-Brandes**, Footscray, Sidcup, Kent.
29 **Radio Gramophone Development Co.**, 3, Hampton Court Parade, East Molesey, Surrey.
32 **Multicore Solders**, Maylands Avenue, Hemel Hempstead, Herts.
33 **Baird Television**, Lancelot Rd., Wembley, Middx.
34 **Sobell Industries**, Langley Park, Nr. Slough, Bucks.
35 **A. J. Balcombe**, 52, Tabernacle St., London, E.C.2.
36 **Pye**, Radio Works, Cambridge.
37 **A.C. Cossor**, Cossor House, Highbury Grove, London, N.5.
38 **Philco (Overseas)**, Lion House, Richmond, Surrey.
39 **Roberts' Radio Co.**, Creek Rd., East Molesey, Surrey.
40 **Dynatron Radio**, Portacte Works, Ray Lea Rd., Maidenhead, Berks.
41 **Goodmans Industries**, Axiom Works, Wembley, Middx.
42 **Telegraph Construction & Maintenance Co.**, Telcon Works, Greenwich, London, S.E.10.
43 **J.G. Publications**, 32, Vauxhall Bridge Rd., London, S.W.1.
44 **"British Radio & Television,"** 92, Fleet St., London, E.C.4.
45 **Trader Publishing Co.**, Dorset House, Stamford St., London, S.E.1.
46 **Automatic Coil Winder & Electrical Equipment Co.**, Winder House, Douglas St., London, S.W.1.
47 **Simon Sound Service**, 48/50, George St., London, W.1.
48 **Sharston Manufacturing Co.**, 21, Hyde Way, Welwyn Garden City, Herts.
49 **Westinghouse Brake & Signal Co.**, 82, York Way, Kings Cross, London, N.1.
50 **Aerialite**, Castle Works, Stalybridge, Cheshire.
51 **Barclays Bank**, 54, Lombard St., London, E.C.3.
52 **Geo. Newnes**, Tower House, Southampton St., London, W.C.2.
53 **Taylor Electrical Instruments**, 419, Montrose Avenue, Slough, Bucks.
54 **Amplion**, 259, Tottenham Court Rd., London, W.1.
55 **Standard Telephones & Cables**, Connaught House, Aldwych, London, W.C.2.
56 **A. H. Hunt (Capacitors)**, Bendon Valley, Garratt Lane, London, S.W.18.
57 **Evor Ready Co.**, Hercules Place, Holloway, London, N.7.
58 **Pilot Radio**, 31/37, Park Royal Rd., London, N.W.10.
59 **Philips Electrical**, Century House, Shaftesbury Avenue, London, W.C.2.
61 **Decca Record Co.**, 1/3, Brixton Rd., London, S.W.9.
62 **Edison Swan Electric Co.**, 155, Charing Cross Rd., London, W.C.2.
63 **Masteradio**, 10/20, Pitaror Place, London, N.W.1.
65 **"The Year,"** 12/22, Bouverie St., London, E.C.4.
66 **Ace Radio**, Tower Works, Pound Lane, Willesden, London, N.W.10.
67 **English Electric Co.**, Queens House, Kingsway London, W.C.2.
68 **E.M.I. Sales & Service**, Hayes, Middx.
69 **McMichael Radio**, 190, Strand, London, W.C.2.
70 **Ultra Electric**, Western Avenue, Acton, London, W.3.
71 **Invicta Radio**, Parkhurst Rd., Holloway, London, N.7.
72 **Telegraph Condenser Co.**, Wales Farm Rd., North Acton, London, W.3.
73 **Rola Celestion**, Ferry Works, Summer Rd., Thames Ditton, Surrey.
74 **Odhams Press**, 96, Long Acre, London, W.C.2.
75 **Iliffe & Sons**, Dorset House, Stamford St., London, S.E.1.
76 **Wolsey Television**, 75, Gresham Rd., Brixton, London, S.W.9.
77 **Lee Products**, 99, Gt. Eastern St., London, E.C.2.
78 **General Electric Co.**, Magnet House, Kingsway London, W.C.2.
79 **Dubilier Condenser Co.**, Duson Works, Victoria Rd., North Acton, London, W.3.
80 **Plessey Co.**, Vicarage Lane, Ilford, Essex.
81 **Lloyds Bank**, 71, Lombard St., London, E.C.3.
82 **National Provincial Bank**, 15, Bishopsgate, London, E.C.2.
83 **Telequipment Electronic Instruments**, 73a, Beresford Rd., Hornsey, London, N.8.
85 **Pamphonic Reproducers**, Westmoreland Rd., Queensbury, London, N.W.9.
86 **Association of Radio Battery Manufacturers**, 41, Gordon Square, London, W.C.1.
87 **Marconiphone Co.**, Hayes, Middx.
88 **Ferguson Radio Corporation**, 100, Judd St., London, W.C.1.
89 **Gramophone Co.**, Hayes, Middx.
90 **Vidor**, West St., Erith, Kent.
91 **Collaro**, Ripple Works, Bye-Pass Rd., Barking, Essex.
92 **Garrard Engineering & Manufacturing Co.**, Newcastle St., Swindon, Wilts.
93 **Livingston Laboratories**, Retcar St., Dartmouth Park Hill, London, N.19.
94 **Chloride Batteries**, 6/10, Whitfield St., London, W.1.
95 **Whiteley Electrical Radio Co.**, Radio Works, Victoria St., Mansfield, Notts.
96 **Linguaphone Institute**, 207/209, Regent St., London, W.1.
97T **Brown Brothers**, Browns Buildings, Gt. Eastern St., London, E.C.2.
98T **Kerry's**, Warton Rd., Stratford, London, E.15.
99T **Hirbday Bros.**, 21, Gt. Eastern St., London, E.C.2.
100T **Fetter Radio & Electrical Supplies**, 291/7, Forest Rd., Walthamstow, London, E.17.
101T **L.E.S. Distributors**, 15, Alfred Place, London, W.C.1.
102T **J. J. Eastick & Sons**, 12, Errol St., London, E.C.1.
103 **Waveforms**, Radar Works, Truro Rd., London, N.22.
104 **Keith Prowse & Co.**, 159, New Bond St., London, W.1.
106 **Gramophone Co.**, Hayes, Middx.
121 **Sail**, 79a, St. Leonard's Rd., Windsor, Berks.
122 **Valradio**, New Chapel Rd., Feltham, Middx.
123 **W. G. Turnidge**, 8t, Andrews Walk, Bethnal Green, London, E.2.
124 **Stratton & Co.**, Eddystone Works, Alvechurch Rd., West Heath, Birmingham, 31.
125 **Electrical Trades Union**, Hayes Court, West Common Rd., Bromley, Kent.
126 **Television Society**, 164, Shaftesbury Avenue, London, W.C.2.
127 **Bernards (Publishers)**, The Grampians, Western Gate, London, W.6.
128 **White-Ibbotson**, 205, Station Rd., Harrow, Middx.
129 **British Broadcasting Corporation**, Broadcasting House, London, W.1.
130 **Admiralty**, Whitehall, London, S.W.1.
131 **Air Ministry**, Parliament Square House, Parliament St., London, S.W.1.
132 **War Office**, Whitehall, London, S.W.1.
133 **Champion Electric Corporation**, Champion Works, Newhaven, Sussex.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

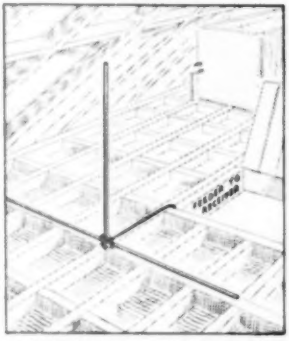
The Radio Show

To many of us who live with Radio, Television and Electronics generally, the time between exhibitions seems to fly. We are writing these words in July and are up to our necks in arrangements for the National Radio Show, Earls Court, which opens as this issue is published.

The "Belling-Lee" stand No. 25, located in the main centre avenue, will be more attractive than ever, and will include three working exhibits :—

1. A model of a site with transmitter, cooling towers and receiving aerial, with a real television receiver, showing how a "Multirod" can be rotated so as to cut out a reflected signal, in this case from the cooling towers.
2. Another model site, which shows model cars in motion. Some cars are suppressed, others unsuppressed. Again the effect is shown on a television receiver. This illustrates that courtesy extends further than the road.
3. A television aerial is shown being subjected to vibration and stroboscopically illuminated.

A New Inverted "T," The "Lofrod"



The "Belling-Lee" "Lofrod."

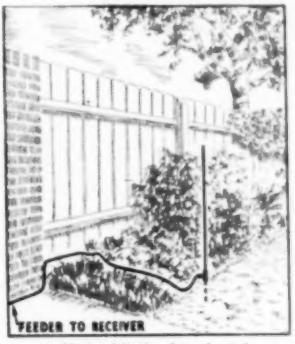
The range of television aerials has been increased to include an adjustable and rotatable inverted "T," suitable for loft use, which we will sell under the registered trade mark "Lofrod."

The New "Unirod" Garden Aerial

The "Unirod" garden aerial is an entirely new aerial for use in areas of swamp signal.

The horizontal arms of any inverted "T" form an earth plane, in fact they represent an artificial earth.

In the "Unirod" garden aerial, the actual earth takes the place of the artificial one, a short length of the "lower element" being driven into the earth. The insulator and the "upper element" are perfectly normal. While we do not claim any magic powers for this new



"Unirod" Garden Aerial.

aerial, we do feel that the following six points are in its favour :—

1. Generally greater signal pick-up than a ground floor "Doorod."
2. Less prone to picture flutter due to movement of personnel in the house.
3. Reduces ignition interference if erected at the rear of the house.
4. Less picture flutter due to passing aircraft.
5. Variation of earth resistance does not affect the picture.
6. Very easily installed (just push it in).

We cannot emphasise too strongly that the "Unirod" garden aerial is only suitable in areas of strong signal. It should always give better results than any indoor aerial on the ground floor. Care should be taken to site it suitably, clear of any metal down-pipes, metal fence posts, metal pergola or clothes poles, wire netting, etc.

"Eliminoise" Aerial System

This famous anti-interference system has been redesigned and is now much smaller and thoroughly sealed against the ingress of water. It has been tested in our humidity chamber and has passed with flying colours. In order to draw it to the attention of visitors to the exhibition, the aerial transformer will be immersed in a tank of water for the duration of the exhibition, and will

The Long and Medium Wave "Eliminoise."

be coupled to meters which will indicate the result of the appropriate tests.

Aircraft Flutter

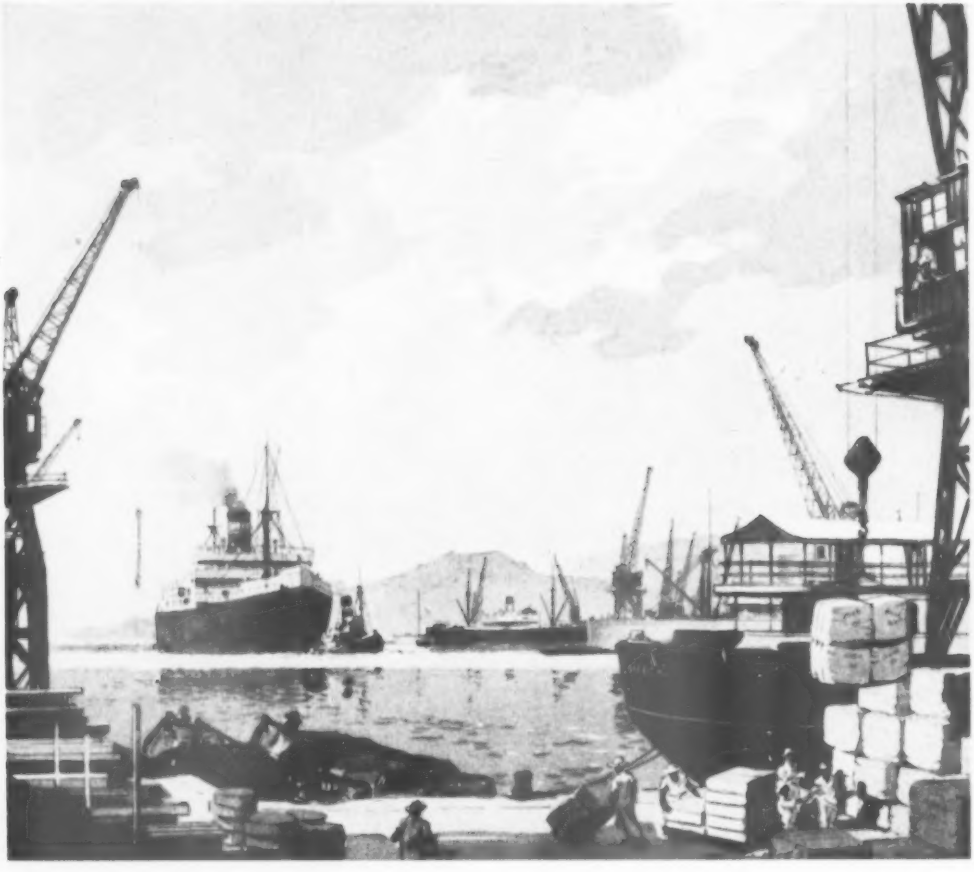
We manufacture and sell a television aerial called the "Veerod" which may be erected either like "V" or like "A." We have, on previous occasions, warned our readers that if they live anywhere near an airfield or on an aircraft route, that such an aerial should not be used. Any aerial with one or more limbs tilted from the vertical is liable to variations in signal pick-up and resultant picture flutter. The same remarks apply to the "Doorod" if used other than as a vertical dipole., e.g., the "Doorod" may be used as a dipole, as a "V" or with one limb horizontal. We repeat, if an aerial intended for British television, is erected with one or more elements other than vertical, this trouble may occur. We have, at times, recommended that a dipole be laid on its side or tilted, as a means of evading a "ghost," but this again would make the aerial more susceptible to picture flutter. The same thing happens when a "Multirod" is tilted to meet a falling wave front. It is mainly for this reason that we do not, as a matter of course, tilt our "fringe" aerials. Why make an aerial directional to a most annoying form of interference? There may be isolated cases where the user is prepared to put up with flutter in order to get any picture, or where passing aircraft are few, then tilt the aerial if it improves the picture.

We tilted aerials in the earliest days of television and told the world why we did it, but we withdrew the outdoor "Veerod" because it was too sensitive to aircraft.

Written 26th July, 1952

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND

MARCONI communication systems



serve mankind

Before Guglielmo Marconi's invention of wireless, a ship out of sight of land was literally cut off from the world. Today you can, in a matter of minutes, contact a ship in mid-Atlantic. Such is the measure of his service to communications and safety at sea. Such too, is the measure of his ideals, which still inspire the Company he founded.

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Army Communications

The Rôle of the Signals Research and Development Establishment

OF the many establishments concerned with the development of communications in the fighting services, those providing for the needs of the Army and the R.A.F. are co-ordinated under the Ministry of Supply which is responsible for seeing that duplication of effort is avoided and that standardization, where possible, is not precluded.

The Signals Research and Development Establishment at Highcliffe, near Christchurch (formerly the Signals Experimental Establishment, Woolwich), is concerned primarily with the needs of the Army, and its functions, both active and passive, play an essential part in translating operational requirements into realizable designs, which can be made in quantities by the resources of industry.

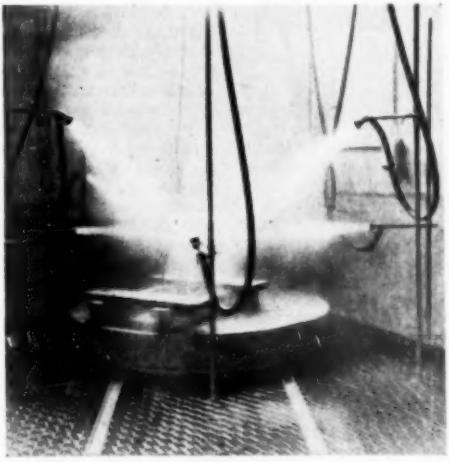
Many of its most intriguing activities are at the moment subject to security regulations, but during a recent visit sufficient was seen to enable an appreciation of the value of the Establishment's routine work to be made.

The main divisions are broadly: Research, Development, Technical Services and Engineering. Lines of demarcation between the divisions are not rigid, and all are well versed in the kind of misuse—perhaps it would be kinder to say, the normal stresses—to which apparatus is subjected by the Army in the field.

Some indication of the severity of these stresses is gained when one sees the refined instruments of torture which have been devised by the Technical Services Department merely to simulate, and not necessarily to exceed, known conditions of transport and use. Methods of packing, which are devised by the Engineering Division, are tested by vibration and drop tests and equipment which is amenable to air transport is tested at the low temperatures and pressures associated with high altitudes. Materials for colour codes and printed scales are subjected to ultra-violet radiation equivalent to intense sunlight, and desert sandstorms are simulated in yet another test chamber. Meters and valves are given impact tests which in some cases are the equivalent accelerations 100 times that due to gravity. Equipment subjected to sustained vibration from the engines of transport or armoured fighting vehicles is examined stroboscopically over a wide frequency range on a vibration table. Under these conditions an ordinary broadcast receiver presents a nightmarish spectacle of weaving surfaces and rocking components with first one section then another losing stability as the frequency is raised.

Much thought has recently been given to the waterproofing of radio equipment for operations involving beach landings and the wading of rivers, and a demonstration was given of the use of resealable protective covers for handcart, trailer and truck wireless transmitting and receiving stations.

Another interesting demonstration showed the method of handling aerial masts from 30 to 100 ft in height and designed, by the Mechanical Design Group of the Engineering Division, for vertical erection. Not only are these masts capable of carrying comparatively heavy top loads in the form of special aerial arrays, but they do not require the open space formerly needed for derrick erection and can be pushed up through tree cover without disturbing the terrain.



"Driving rain" test for splash-proof components (in this case a re-entrant horn loudspeaker). More searching tests are arranged for equipment classified as waterproof.

An important section of the Technical Services Division is the Components Development Group whose responsibility it is to investigate new principles and materials which may show promise of improving reliability, stability of performance or reduction in size of communications components. Demonstrations were given of sensitive test equipment for indicating the temperature coefficient of capacitance or inductance. Examples were shown of new d.c./a.c. vibrators with increased output, and electromagnetic relays designed to be immune from false operation due to external shocks. Among new materials being investigated were noted glass and enamel glaze dielectrics for small fixed capacitors, and inter-granular barrier layer dielectrics for larger capacitors. The latter consist of partially reduced titanium oxide powder, sintered in an oxidizing atmosphere, and have greater stability at high temperatures than electrolytic capacitors. They are suitable for frequencies below 10 kc/s and have a minimum "Q" in the region of 100 c/s which points to the possibility of use in tuned smoothing circuits.

The Radio Group of the Development Division is responsible for the design of communications equipment for use by the Royal Corps of Signals and for infantry, vehicular and tank sets, which are frequency-

Operating a transmitter-receiver at a temperature of — 40 degrees Fahrenheit.

modulated at v.h.f. By comparison with the infantry pack sets used during the last war, the latest designs show an appreciable, though not spectacular, reduction in weight. Where they do score is in the reduction in size and the silhouette presented to the enemy; it is now a matter of some difficulty to spot the signaller in a platoon. Intensive miniaturization, with whole i.f. stages now occupying the space formerly taken by a "miniature" coil can, is largely responsible, but much ingenuity has been exercised in the layout of sub-assemblies, which leave no wasted space and which are colour-coded to facilitate replacement by semi-skilled men.

The new tank sets chassis, when withdrawn from their cast-metal containers, open out like a book to give access to valves and components. When closed the only wiring to be seen is the power supply and interconnecting leads between sub-assemblies. Three transmitter-receiver channels are provided for communication between tank and infantry, between tanks in a troop and between troops in a squadron. "Netting," in which receivers are tuned to the arbitrary frequency of a master transmitter, has given place to independent frequency selection by reference to built-in crystal calibrators.

Testing waterproofed equipment by operating a v.h.f. handcart set "on the wade."

Although radio developments are apt to steal the picture on occasions like this, it is salutary to be reminded that the bulk of the Army's communications are still carried by wire, and a large and active Lines Group at S.R.D.E. concerns itself with telephone and telegraph equipment. Of course, there is inevitably some overlapping of line and radio methods, and in the latest multi-channel carrier telephone equipment which is of compact unit construction, soldered-in miniature valves were noted. In a two-wire audio repeater, which gives the equivalent of four-wire working over distances up to 25 miles, carrier methods are also used for one direction.

The speed of laying of field cables has been increased by the development of twin-twisted non-kinking copper-steel conductors, polythene insulated and nylon-sheathed, which can be laid from a dispenser drum at speeds up to 100 m.p.h.

A new teleprinter having a quarter the weight of the present Army teleprinter was shown. The use of a travelling-type basket instead of a travelling drum has decreased the overall width to that of a man, so that bench space is saved in mobile units. Speeds up to 100 w.p.m. are available.

To find what are the essential elements in speech intelligibility and if possible to effect a reduction in the required transmission bandwidth, the Lines Group are undertaking research involving the synthesis of speech from elements of known characteristics. These take the form of hand-drawn sound tracks which are converted to audio currents through a photocell. Some astonishingly life-like effects have been produced.

The problems of speech intelligibility through the high ambient noise (90 to 110 phons) in a tank are being tackled by the Electro-acoustics Group which is engaged on a statistical analysis of special "immediate appreciation" articulation tests carried out in a soundproof room in which the acoustic environment, simulating battle conditions, is provided by banks of loudspeakers covering the whole of one wall and fed from a 1-kW audio amplifier. Other work of this department includes routine measurements on microphones, headphones and loudspeakers, the development of a limited number of standard transducers to reduce the range of types in service, and the design in conjunction with industry of blast-proof loudspeakers.

In addition to its function as a prime mover in research and development, S.R.D.E. constitutes a buffer state between Army and Industry and ensures continuity in the execution of long-term plans for re-equipment, irrespective of changes in Army Staff or industrial management. These aspects are admirably summed up in the words of Dr. G. W. Sutton, the Chief Superintendent: "The function of the Establishment, therefore, emerges quite clearly, though a written specification of this function is not quite so easy to formulate. It is partly an inductive element, since it must maintain continuity of philosophy and consequent action. It is partly capacitive, since it must absorb transient forces arising at either end of the circuit. Perhaps it is not inappropriate to regard it also as a resistive element, since it is a convenient place in which to allow inevitable surges of technical opinion to become dissipated."

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Too Many Recording Characteristics?

I AM afraid that Ruth Jackson's suggestion in the August issue with regard to the recording characteristics difficulty would be no solution of the problem, even if recording companies did agree on a standard characteristic. As things are, the companies do not appear to adhere any too strictly to their various characteristics, and indeed it is hardly practicable to apply the same measure of top pre-emphasis to, for example, a recording of a female choir as is sometimes now applied to band or orchestral recordings, unless the recording level is very considerably reduced. In any case, widely variable equalization would still be required at the reproducing end to cope with the peculiarities of loudspeakers, listening room characteristics, and microphone placing at the actual recording, to say nothing of the individual listener's preferences with regard to balance. I consider the only solution lies in the provision of four independent controls, two each for bass and treble, giving a wide variation of both slope and point of origin to the equalization curves. The present tendency to provide switched equalization for the four major recording characteristics is in my experience quite inadequate.

Honiton, Devon. R. MARKER.

THE entry of a member of the opposite sex into the arena of audio controversy is a welcome event, but I am sorry that Ruth Jackson should have abandoned the realism and practical commonsense usually attributed to her sex in joining those starry-eyed males who think that there is some virtue in devising correction circuits which are the exact complement of published recording characteristics. Do these give more than compensation for the performance of the cutter head and its associated amplifier? What of the studio acoustics and the microphone characteristics, the "recording technique" of the performers and the opinion of the recording company's musical director if he is not satisfied with the first playback; are all these included in the characteristic? If not, then I say that there are not enough "recording characteristics," and that ultimately there should be one for each disc in the catalogue. And what will the amplifier makers do then, poor things? What the wise ones already do; give the customer the widest possible variable controls and let *him* get on with it.

HENRY MORGAN.

Hindhead, Surrey.

The Nanofarad

FROM time to time, in various journals, correspondents call attention to the virtues of the nanofarad, with its abbreviation nF; but there seems to be no general move in Great Britain to adopt it. This seems a pity, for its advantages are manifest. The average capacitance used in radio engineering is of the order of 10^{-9} F, and one never quite knows whether to write it 0.001 μF or 1,000 pF. That 1nF is preferable to either seems too obvious to need emphasis. The less one has to use μ the better, for it is not provided on typewriters; and when it comes to 0.01 μF and 0.1 μF the alternatives in pF are clumsy.

Another strong point in favour of using the nF is that fewer people would have an excuse for the irritating and time-wasting practice of writing component values as a separate list instead of on the circuit diagram. Almost all capacitances could be stated in reasonably small whole numbers, followed by p, n, or nothing, for F and μ are redundant when written alongside a capacitor symbol.

The only conceivable explanation for not having joined our European and other friends on this seems to me the characteristic British reluctance to be unconventional. I remember when anybody who ventured to talk pF excited either mystification or hilarity, but now no radio engineer would be without his puffs. "Resistor" was once considered pedantic, but has completely won through; and "capacitance" and "capacitor" are well on the way. I do not accept the defeatism of those who say it's no use trying to alter illogical terminology and conventions because they are too firmly rooted. From now on I intend to join the nF minority, and I urge this course on all who are not afraid to do now what everyone will be doing in ten years' time.

Bromley, Kent. M. G. SCROGGIE.

Colour Coding

I NOTE with pleasure in the June *Wireless World* that R. V. Goode expresses the opinion that the "spot" colour should always be a band.

At the first Radio Exhibition at which colour-coded resistors were displayed, I pointed out to the assistant that trouble would be caused when the resistor was fixed so that the spot became invisible. However, it takes more than a single suggestion at an exhibition followed by a letter to bear fruit. That the spot is becoming rarer is at least satisfying, and I trust that soon it may become a radio crime.

I now have another suggestion to make. It derives directly from the fact that the "spot" colour is the one which determines the position of the decimal point, and is therefore vastly more important than either of the others. The decimal point colour to be found on a cathode bias resistor is not found on the third band of an anode resistance or a grid leak. My suggestion is, therefore, that in accord with its predominating importance, this third band be emphasized.

I therefore ask those resistor manufacturers who *must* follow a detailed specification, to make that important third band as wide relative to the other two as the tolerance permits. To those who make for the public and the set builder, I ask, please make that band as wide as you dare. Two, three or even four times as wide as the others. Approximately 40 per cent to 50 per cent of the resistor length might be a suitable width. To those who draft specifications, I ask that you call for wide third colour bands as suggested above.

Then, perhaps, one day electronic equipment will contain "easy-find" resistors which by their predominating colour literally radiate information as to whether they have high, low or medium values. The service technician, when checking a particular cathode

resistor or grid leak will be able to pick it out instantly, instead of having to make a detailed search as at present, when 1.5 MΩ and 550 ohms actually have identical colours, though theoretically running in opposite directions.

Toronto, Canada. P. G. A. H. VOIGT.

Frequency Response Measurements

THE letter from Henry Morgan in your July issue seems to imply that response curves, as normally used in audio measurements, are either misleading or worthless.

Mr. Kelly, who is referred to in the letter, is a fellow Yorkshireman and happened to be on a visit when the above letter appeared. He spent some of his holiday helping me with loudspeaker response curve oscillograms, which seem to show that although in theory Mr. Morgan may be correct, in practice there is nothing to his arguments.

If a trace covering 20 to 500 c/s in 7 seconds is repeated, but the frequency is allowed to remain constant for about ½ sec. at 50, 100 and 500 c/s the steady frequency simply forms a natural part of the continuous trace. The reason is, of course, that sound frequencies are extremely rapid vibrations, and if the audio range is covered in 15 to 20 seconds there is ample time to get a picture of the true performance.

Mr. Kelly's explanation is in the following words: "The velocity of frequency variation can be neglected providing the rate of change of frequency with respect to time is sufficiently small compared with the rate of change of amplitude with respect to frequency of the circuit under test. To bring a sordid note of reality into this discussion I would hesitate to guarantee any measurements made on electro-mechanical or electro-acoustic apparatus to better than ± 1 db, using commercially available test equipment such as valve voltmeters, gramophone records, etc., under normal uncontrolled conditions. Under these circumstances whilst the argument 'When is a cycle not a cycle?' is an interesting hypothetical discussion, I think it bears no relation to actual practice, always providing the engineer knows what he is doing."

Wharfedale Wireless Works, Idle, Yorks. G. A. BRIGGS.

Jargon

YOU give a monthly display, to our delight, of strength in physics, but I venture to express regret that chemistry appears to be a weaker subject. (Your second leader, July, 1952.)

"Jargon" is a rare gas (though perhaps not rare enough) exhaled by civil servants, motor car salesmen and estate agents. That given off by the B.B.C.—the collection of which involves no exceptional bandwidth acceptance—is (*pace* Ramsay et Rayleigh) "Skrypton."

Ringwood, Hants. ROBERT BRIGGS-BURY.

Towards International Broadcasting

THE medium-wave band is overcrowded, and sooner or later we in Western Europe will have to change over to metre waves for our internal services. But, as metre waves have a restricted range, we must then take steps to ensure that we can listen to each others' programmes.

The existing medium-wave (and also long-wave) channels could still be used for international exchanges, but, in these days of post-war financial stringency, cost may be a problem, especially for the smaller countries.

By sharing the cost, this difficulty could be overcome. I suggest one high-power station each for the smaller countries and perhaps two or three each for Great Britain and France. The stations would radiate first-rate programmes, predominantly musical to overcome the language difficulty. Short announcements might be multi-lingual. The radio or cable interconnections necessary might also be used for exchanges of television programmes.

Expenses of the international service could be covered by a union of the "ENFRABENELUX"* countries, each country contributing according to her number of listeners.

Rotterdam, Holland. C. L. ZAALBERG.

* Presumably England-France-Belgium-Netherlands-Luxembourg.—ED.

What is a Thermostat?

SOME confusion seems to exist over the use of the word "thermostat," which is generally, but apparently not always, used to describe a device that operates by breaking the circuit.

For automatically heat-regulated devices where the electrical circuit is not broken (which have the incidental advantage of not producing radio interference) I feel a new word is needed.

Bexley Heath, Kent. A. E. DURRINGTON.

[We agree. "Thermostat" is defined in B.S.205 as "an automatic device responsive to changes in temperature. In electrical work it usually opens or closes a circuit."—ED.]

"*Pre-recorded*"

THE words of your correspondent R. P. Truman (July issue), who protested against the B.B.C.'s use of the meaningless term "pre-recorded," seem to have sunk in. I have not heard it used since.

All the same, the B.B.C. still fail consistently to say what they probably mean when referring to recording. Early the other morning (6.55 a.m.) the announcer said "'Bright and Early' was recorded this morning by the . . . Band." Cruelty to musicians, I call it! Why not have allowed the poor fellows to record their performance at a reasonable hour the day before, or, if bandsmen are in fact early risers, have given us the benefit of a "live" performance!

Then we have the seemingly straightforward announcement "The programme was recorded." But the seeds of doubt are sown in our minds by an occasional statement that "The programme was recorded, and will be heard on the Light Programme at . . ." Can we be quite sure that we have been actually listening to a recording in both cases? "The programme was broadcast from a recording" would at least be unambiguous.

The suspicion arises in my mind that in this matter the B.B.C. suffers from an inferiority complex; they know in their hearts that they are failing to make the best use of the outstanding advantage of our medium and strive subconsciously to conceal the fact that they use so many recordings. Broadcasting can present living actualities in a manner unrivalled by the printed word or the gramophone record.

London, S.W.7. CHARLES P. SLOAN.

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Amplifiers and Superlatives

An Examination of American Claims for Improving Linearity and Efficiency

By D. T. N. WILLIAMSON* and P. J. WALKER†

Recent articles, particularly in the United States, have shown that some confusion of thought exists about the "goodness" of an amplifier for reproducing sound. This has been accompanied by a debasement of the terms used to describe the properties of an amplifier; words that have a precise meaning when standing alone become meaningless when qualified by superlatives. This article, which starts with a discussion of what constitutes a good amplifier, attempts to clear up some misconceptions and generally to clarify the position.

THE most commonly specified parameter of an amplifier is its harmonic distortion or intermodulation content, and this has tended to be regarded as the primary standard of "goodness." In 1944, one of the writers suggested[1] that a standard of 0.1 per cent total harmonic distortion at maximum output was a good level of performance to aim at. Such a low distortion content is readily achievable by modern design methods, and is, in fact, undetectable by listening tests, however refined. This arbitrary figure was chosen, not because it was the maximum permissible, but because, being rather lower than was absolutely necessary, a good margin is left for any deterioration of the equipment when in service.

The requirements for a good amplifier were listed in the article already mentioned, but are worth repeating and extending. These are:—

(1) Negligible non-linearity distortion up to the maximum rated output. (The term "non-linearity distortion" includes the production of undesired harmonic frequencies and the intermodulation of component frequencies of the sound wave.) This requires that the dynamic output/input characteristic be linear within close limits up to the maximum excursion of any waveform, with frequency components inside and outside the working range, which is likely to be fed to the amplifier. This should hold good under conditions of varying load impedance such as are likely to be encountered in practice.

(2) Linear frequency response within the audible frequency spectrum of 10-20,000c/s.

(3) Negligible phase shift within the audible range. Although the phase relationship between the component frequencies of a complex steady-state sound does not appear to affect the audible quality of the sound, the same is not true of sounds of a transient nature.

(4) Good transient response. In addition to low phase and frequency distortion, other factors which are essential for the accurate reproduction of transient waveforms are the elimination of changes in effective gain due to current and voltage cut-off in any stages, the utmost care in the design of iron-cored components, and the reduction of the number of such components to a minimum. Changes in effective gain during "low-frequency" transients occur in amplifiers with output stages of the self-biased Class AB type, causing serious distortion which is not revealed by steady-state measurements. The transient causes the current in the output stage to rise, and this is followed, at a rate determined by the time-constant of the biasing network, by a rise in bias voltage which alters the effective gain of the amplifier.

(5) Low output resistance. This requirement is concerned with the attainment of good frequency and transient response from the loudspeaker system by ensuring that it has adequate electrical damping. The cone movement of a moving-coil loudspeaker is restricted by air loading, suspension stiffness and resistance, and electromagnetic damping. The efficiency of a baffle-loaded speaker is rarely higher than 5-10 per cent, and the air loading, which determines the radiation, is not high. Electromagnetic damping is therefore important in controlling the motion of the cone. This effect is proportional to the current which can be generated in the coil circuit, and is therefore proportional to the total resistance of the circuit. The output resistance of the amplifier therefore should, in general, be much lower than the coil impedance.

(6) Adequate power reserve. The realistic reproduction of orchestral music in an average room requires peak power capabilities of the order of 15-20 watts when the electro-acoustic transducer is a baffle-loaded moving-coil loudspeaker system of normal efficiency. The use of horn-loaded or other efficient loudspeakers may reduce the power requirement to the region of 10 watts. In an amplifier for the best possible quality it is, of course, assumed that output peaks required in practice will be comfortably below the maximum available. Even so, good design should ensure that the overload characteristic will not suffer temporary paralysis or "blocking" on momentary overload.

(7) The level of hum and noise should be at least 80db below maximum output.

This is a formidable specification, and by no means every amplifier styled as "high quality" will meet it. However, provided that these requirements are met *in every respect* and that extraneous components occurring within the audio range (produced either by components inside or outside that range) do not

* Ferranti Research Laboratories.
† The Acoustical Manufacturing Company.

[1] M.O. Valve Co., Ltd. Internal Report No. Q253, later published as "Design for a High-Quality Amplifier," by D. T. N. Williamson. *Wireless World*, April-May, 1947.

exceed a small fraction of 1 per cent, any amplifier will sound as good as any other amplifier and it becomes impossible to "improve" a power amplifier in the sense of producing better sound.

Efficiency.—On the other hand it is, of course, absurd to say that amplifiers cannot be improved in any sense. Efficiency, compactness, and reliability are important and it is with regard to these factors that improvements are possible and in many cases desirable. The size and purpose of an amplifier will determine how much weight should be given to each of these factors.

In small amplifiers with power outputs below twenty watts, power efficiency is not usually of prime importance, and other considerations such as ease of construction and certainty of results may easily outweigh it. With large amplifiers, efficiency becomes a very important factor. Sometimes it is not possible to produce a high output *unless* the efficiency is high, because of valve dissipation limits.

Controlled and Uncontrolled Production.—The designer's aim is (or should be) to produce the best possible sound for those who will ultimately make use of his efforts. If he designs for construction not under his control, he must, as far as possible, ensure that every amplifier made will meet his performance figures without undue difficulty and with the employment of limited measuring equipment. In such a case, the avoidance of circuitry which is not straightforward, or in which deviations from specification in the values and construction of components is liable to produce poor results, is paramount.

The designer who has control over the production of the complete equipment has a different set of problems. He has much greater freedom of choice, and it is likely that he will arrive at different circuitry.

The amplifier which was described in *Wireless World*, April-May, 1947, is an example of the first kind of circuitry. The success it has achieved since then, in the hands of people with widely varying degrees of skill, is indicative that trouble-free performance is readily obtainable with only simple adjustments. This amplifier was based upon a triode output stage with a good output transformer, the performance of which was improved by overall negative feedback.

The only valid criticism which can be made about its performance is on the score of efficiency. The output of about 15 W is produced for an h.t. consumption of 56 W, an efficiency of only 27 per cent. By the use of tetrodes as output valves this could be raised to the order of 35-40 per cent, which means that, for the same power consumption, the output could be increased to 22 W, or, alternatively, that the power consumption could be reduced by about 20 W.

Whether this is worth doing or not is problematical. In the designer's opinion, the additional risk of trouble in unskilled hands outweighs the advantage of higher maximum power output, as in the vast majority of cases even the present level of output cannot be fully utilized. The reduction in power consumption and h.t. voltage would not greatly affect the cost, although it would give a higher factor of safety for the capacitors in the circuit. There is, however, no evidence that this is at present inadequate.

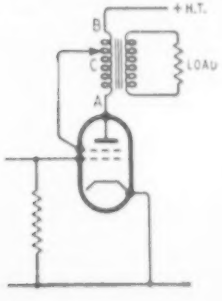
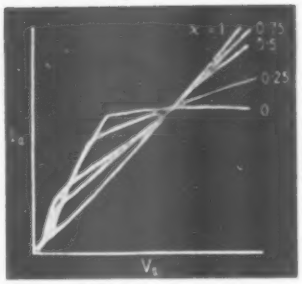


Fig. 1. Basic circuit used by Hafler and Keroes.



Oscillogram showing transition of I_a-V_a curves from tetrode to triode form as the tapping point in Fig. 1 is moved from B to A.

Circuits with Distributed Loads.—Articles [2, 3] have recently been published in the United States claiming the superiority of a so-called "ultra-linear" output circuit in which the output valves are used as tetrodes, with negative feedback applied non-linearly by connecting the screens to a tap on the primary of the output transformer. It is stated that the performance is audibly improved over that of triodes with similar degrees of negative feedback.

The present writers do not believe this claim. The circuitry which forms the basis of these American claims for "ultra-linearity" and higher efficiency has, in fact, been familiar in this country for several years, and the technique has been further developed and used in a commercially produced high-quality amplifier.[4, 5] It consists of the distribution of the load impedance between the electrodes of each output valve in order to obtain the optimum performance from that valve.

In its simplest form, and as used by Hafler and Keroes, the circuit arrangement is as shown in Fig. 1. The circuit is normal, except that the screen of the tetrode can be tapped on the output transformer primary winding, thus coupling it to the anode in any ratio, and rendering a section of the load impedance common to both electrodes. If the tap is affixed at point A, giving a coupling factor of unity, the stage behaves as a triode, its performance being determined by the dynamic characteristic of the screen and control grid, and if the tap is shifted to point B, the coupling factor is zero, and the stage behaves as a simple tetrode. If now the screen is tapped at intervals between point B and point A, there will be a progressive inclusion of the load impedance in the screen circuit and a progressive change from tetrode characteristics at B, to triode characteristics at A.

It is convenient to consider the stage as being a tetrode with negative feedback applied to the screen. It differs from a tetrode stage with feedback applied to the control grid, first in that the screen introduces a non-linear element in the feedback loop, and secondly, because as the degree of feedback is in-

[2] Hafler and Keroes: "An Ultra-linear Amplifier," *Audio Engineering*, November, 1951, pp. 15-17.
[3] Hafler and Keroes: "Ultra-linear Operation of the Williamson Amplifier," *Audio Engineering*, June, 1952, pp. 26-27.
[4] First introduced in 1945; see advertisement of the Acoustical Manufacturing Company in *Wireless World*, July, 1945, p. 10.
[5] Moir: "Review of British Amplifiers," *FM-TV*, October, 1951, pp. 30-32.

creased, the permissible anode swing is decreased, due to anode current cut-off on the negative excursions of screen voltage, until finally the I_a-V_a curves become those of a triode. A more complete account of the behaviour of the circuit is given in the Appendix.

The curves of Fig. 2, which apply to a single valve, show the effect of changing the tapping point. The output at the point of overload, the relative gain and the output resistance decrease as the degree of feedback is increased, the output resistance decreasing very rapidly because it is dependent, not on the gain reduction, but on the amplification factor, which undergoes a large change.

The distortion at constant output, which is predominantly second harmonic, rises slowly at first until the point of overload is reached. Since the maximum power output is progressively reducing, the distortion curves for maximum output or a percentage of maximum output will show a progressive reduction from tetrode to triode operation.

In view of the increase in distortion, as shown in Fig. 2, it would appear that there is little to be gained by the use of this circuitry, since a simple tetrode, with feedback to the control grid, would give a similar reduction of output resistance, and this would be accompanied by a progressive reduction in distortion. This is indeed true in the case of a single valve.

When push-pull connection is considered we obtain a different state of affairs, because of the cancellation of second harmonic components, and we arrive at the curves shown in Fig. 3. The general shape of the curves is maintained under varying loads. With up to 30 per cent of the winding common to screen and anode the reduction in distortion is greater than the reduction in gain. This "something for nothing" is small, however, and can be lost or even reversed if there are appreciable departures from precise balance at any frequency.

It is, of course, not essential to have the screen tapped directly on the primary winding, and an auxiliary winding tightly coupled to the primary (ideally in the form of a bifilar winding) may be used. This has the advantage that the screen supply voltage may differ from that of the anode to give optimum operating conditions.

The "Acoustical" Circuit.—A further development of this circuit ("super-ultra-linear," perhaps?) used in the Acoustical "Q.U.A.D." amplifier and its predecessor, takes the common portion of the winding and inserts it in the cathode, giving the circuit of Fig. 4. As far as the anode and screen circuits are concerned, this arrangement is identical to that of Fig. 1 (neglecting winding resistance and leakage reactance). The only difference lies in the grid circuit, since that portion of the voltage appearing across the common winding is now applied in the grid circuit as overall negative feedback. It is, of course, feedback of the most desirable kind, since it is the most practical method of applying voltage feedback over a single stage without either throwing gain away wastefully or increasing the load on the previous valve.

Since the screen is now connected to a decoupled point, it follows that the designer is free to use different voltages for screen and anode if required, without the necessity of additional windings, with their attendant disadvantages. Further, the arrangement makes it possible to provide the optimum degree of smoothing for the anode and screen supplies. The grid resistor may be taken to the cathode end of the common winding if desired, with the result that the input resistance is increased, thus facilitating the design of the previous stage and reducing the value of the coupling capacitance necessary.

The use of all the electrodes in this way gives additional flexibility in design, so that the parameters of the output stage may be varied to suit the penultimate stage—a technique giving greater scope in arriving at a well-balanced ratio of stage distortions and hence an optimum final design. In the output stage of the Acoustical "Q.U.A.D." amplifier, using two KT66 valves, the values are so chosen that an output of 12

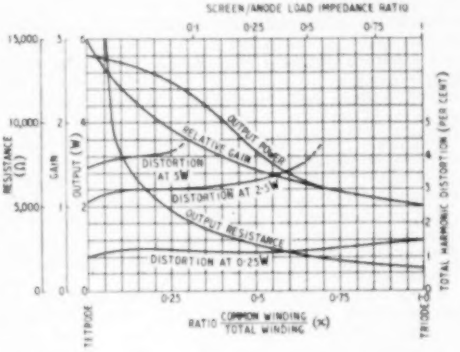
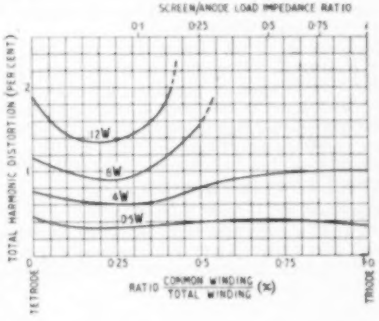
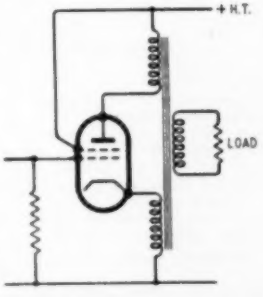


Fig. 2. Curves of output power, relative gain, output resistance and distortion for the circuit of Fig. 1. The distortion components are predominantly second and even harmonics.



Above: Fig. 3. Curves of distortion for a push-pull arrangement (predominantly third and odd harmonics).



Right: Fig. 4. Basic circuit used in the Acoustical Manufacturing Company's "Q.U.A.D." amplifier and its predecessor.

watts is obtained from a 320-V supply with a grid-to-grid input of 72 volts peak, the input resistance being 1 mehogm. The total harmonic distortion of the output stage alone is not more than 0.7 per cent, and the output resistance is approximately half the load resistance.

By comparison with the same valves used as triodes to obtain the same output, the following advantages are apparent:

(1) Distortion is less than half that of triode connection, due to the cathode and screen feedback.

(2) Efficiency is increased from 27 per cent to 36 per cent, resulting in the h.t. voltage being lower by about 100 V, thus simplifying reliability problems both in the amplifier itself and throughout the range of pre-amplifiers, tuners, etc., which may take their supply from it.

(3) Less smoothing is necessary for equivalent hum-levels.

Additional overall negative feedback can be applied to the complete amplifier, and with the ratios used in the above example, 8 db less feedback is required for a given level of distortion than with triodes. This assists in maintaining a good margin of stability and reduces the effect of overloading due to the presence of frequencies in the input which are outside the effective feedback range.

There remains the question of output resistance to be considered, about which there appears to be some confusion. This is probably due to the general use, as a measure of the efficacy of damping, of the load resistance/output resistance ratio, sometimes called the damping factor, the scale of which becomes virtually meaningless at high values. It appears to be common practice to aim at as high a value as possible, with presumably infinity (zero output resistance) as the ideal. An output resistance of zero is, of course, only an arbitrary figure, which has ultimately to be added to the speech coil resistance.

Independently of the output-stage circuitry, zero—or any reasonable value positive or negative—can be obtained by a mixture of negative voltage and positive current feedback. It should be pointed out, however, that the optimum value is dependent upon the loudspeaker and particularly the intended performance of its enclosure, so that the doctrine "the more damping the better," is not always sound.

Comparison of Output Circuits.—To summarize, Table I gives a comparison of the relative merits and demerits of various output circuits. It will be seen that there is little to choose between the performance of triodes and distributed-load tetrodes (especially the cathode-coupled variety), with the exception of efficiency, in which respect the tetrode circuits are superior to the triode.

In order to avoid misapprehension, it should be stated that a similar order of performance is obtainable from a conventional tetrode circuit, by the application of the appropriate degree of negative feedback, preferably in the form of multiple loops to ease the stability problems. The advantage of the distributed-load circuits is that, as a considerable amount of negative feedback is included in the output stage itself, the design of the remainder of the amplifier is simplified and the problems of stability and restriction of scope in design usually associated with large amounts of overall negative feedback are avoided.

Practical Difficulties.—So far we have only been considering the ideal case. In a practical transformer, however, the windings are not perfectly coupled, but are more loosely coupled by a complex network of leakage reactances formed by the distribution of leakage inductance and self-capacitance throughout the windings. This departure from the ideal may mean that, at high frequencies, the circuit is not at all as it would appear on paper, and the effective sense of the coupling may even be reversed, producing oscillation. In a less severe case, peaks and troughs in the frequency response characteristic may occur, accompanied by "ringing" and instability when the amplifier is excited by a transient.

These defects are serious, and can only be avoided by designing the output transformer carefully and by maintaining close control over its production, as even with transformers of the same nominal specification, wide variations in performance at high frequencies may occur due to minor variations in the quality and thickness of insulants, and in the positioning of windings.

The designer who has complete control over production can arrange that the materials and construction of the transformer do not depart from specification, and even if they should do so he has facilities to detect and correct the deviation at an early stage. He is therefore able to make use of circuitry of the type discussed, without the dangers which would attend its use in unskilled hands or where measurement facilities are absent. The advantages obtained have already been discussed.

The constructor with limited facilities cannot be too strongly advised to keep to proven circuits which are inherently trouble-free. In particular, he should

TABLE I

Parameter	Triode-connected tetrodes (Class A)	Tetrodes (Class A)	Tetrodes with load distributed between anode and screen (optimum value)	Tetrodes with load distributed between anode, screen and cathode (Q.U.A.D. arrangement)
Efficiency (per cent)	27	38	36	36
Relative power output	1	1.4	1.35	1.35
Relative distortion just below onset of grid current	1	2	1.5	0.5
Load resistance / Output resistance	2–4	0.05–0.1	0.5–1	2

keep to designs requiring the minimum number of coupled circuits in the output transformer, since the possibility of pitfalls is greatest in this component and increases rapidly with the number of windings when all these must be closely coupled.

It will be appreciated from the foregoing that there are a large number of solutions to the problem of designing a first-class amplifier, and no one of these solutions can be called the best solution. Each has its advantages and disadvantages, and the individual designer must choose that which most nearly meets his needs. The "goodness" of an amplifier is not shown by its circuit diagram. Circuits have no inherent magic properties, but are merely the tools with which the designer seeks to achieve a certain result, and different designers—provided always that they have the same high standards in view—may achieve the same result by different means.

APPENDIX

Let

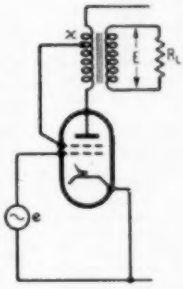
$$\mu = \frac{E_a}{E_g} = g_m R_a, \; m = \frac{E_s}{E_g}$$

$$\therefore \frac{E_s}{E_a} = \frac{\mu}{m}$$

x = fraction of output fed to screen.

E = output voltage in load R_L, produced by grid voltage e.

Neglecting the effect of screen current in the load, which is normally less than 10 per cent,



Current in load due to e

$$= e \frac{\mu}{R_a + R_L}$$

Current in load due to $xE = -xE \frac{\mu}{m(R_a + R_L)}$

$$\therefore \text{Voltage in load} = E = \left\{ e \frac{\mu}{R_a + R_L} - xE \frac{\mu}{m(R_a + R_L)} \right\} R_L$$

$$\therefore e \frac{\mu R_L}{R_a} = E \left(1 + x \frac{\mu R_L}{m R_a} \right)$$

$$\therefore \quad \text{Gain} = \frac{E}{e} = \frac{\mu R_L}{R_a + R_L} \Big/ \left(1 + x \frac{\mu}{m} \frac{R_L}{R_a + R_L} \right)$$

When $x = 0$,

$$\frac{E}{e} = \frac{\mu R_L}{R_a + R_L}$$

when $x = 1$,

$$\frac{E}{e} = \frac{\mu R_L}{R_a + R_L} \Big/ \left(1 + \frac{\mu}{m} \frac{R_L}{R_a + R_L} \right)$$

Output resistance.

Let $R_L \to \infty$, then $\frac{R_L}{R_a + R_L} \to 1$

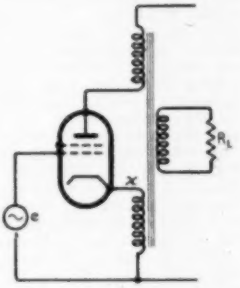
Then gain $(x = 0) = \mu$

$$\text{Gain } (x) = \frac{\mu}{1 + x \frac{\mu}{m}} = \mu'$$

$$\text{Output resistance } (x = 0) = \frac{\mu}{g_m}$$

$$\text{Output resistance} = \frac{\mu'}{g_m} = \frac{\mu}{g_m \left(1 + x \frac{\mu}{m} \right)}$$

"Q.U.A.D." case



Gain is given by

$$\frac{\mu \dfrac{R_L}{R_a + R_L}}{1 + x \dfrac{\mu}{m} \dfrac{R_L}{R_a + R_L}} = A$$

Gain with feedback $= \dfrac{A}{1 + xA}$

$$\text{Gain} = \frac{\mu \dfrac{R_L}{R_a + R_L}}{1 + x \dfrac{\mu}{m} \dfrac{R_L}{R_a + R_L}} \Big/ \left(1 + x \frac{\mu \dfrac{R_L}{R_a + R_L}}{1 + x \dfrac{\mu}{m} \dfrac{R_L}{R_a + R_L}} \right)$$

$$\text{Output resistance with feedback} = \frac{\text{Output resistance without feedback}}{1 + x\mu}$$

$$\text{Output resistance} = \frac{\dfrac{\mu}{g_m \left(1 + x \dfrac{\mu}{m} \right)}}{1 + x \dfrac{\mu}{1 + x \dfrac{\mu}{m}}}$$

RADIO PROPAGATION WARNINGS

New WWV Forecasts.—In addition to giving announcements of *prevailing* radio propagation conditions over the North Atlantic, the service broadcast by WWV—the N.B.S. standard frequency station, Washington—now gives a *forecast* of communication conditions for the next 12 hours.

These radio disturbance forecasts, prepared four times a day, are transmitted in morse twice each hour—19½ and 49½ minutes past the hour—on 2.5, 5, 10, 15, 20 and 25 Mc/s. The letters "N," "U" and "W" continue to be used signifying normal, unsettled and disturbed prevailing conditions, respectively. The letter is now followed by a digit indicating the expected propagation conditions for the next twelve hours. The significance of these numbers is shown in the table. If, for example, propagation conditions are normal but are expected to be only "fair to poor" within the next twelve hours, the forecast would be broadcast as N4 in morse code, repeated five times, i.e., "N4, N4, N4, N4, N4."

Digit	Propagation condition
1	Impossible
2	Very poor
3	Poor
4	Fair to poor
5	Fair
6	Fair to good
7	Good
8	Very good
9	Excellent

WORLD OF WIRELESS

Training Technicians • V.H.F. Broadcasting Plans • More Purchase Tax • Radio Exports

Technical Training Scheme

MEANS of providing more technically trained men in the industry have been constantly before the R.I.C.'s Technical Training Committee and the Radar Sub-Committee of Lord Hankey's Technical Personnel Committee. As a result full-time three-year technical training courses have now been organized by the Ministry of Education and will start in September at five centres in London, the Midlands and the North.

The objective is to provide students so well trained in the theory and practice of electronics that they will be able, on completion of the course, to take their places at once as assistants to qualified research and development engineers. The entry age will be between 16 and 17.

While the appropriate examinations of the City and Guilds and Brit.I.R.E. will be taken during the course, the syllabus, it is understood, will be wider in scope than is required by those bodies and will reflect to some extent the needs of the region. Special attention is to be paid to industrial electronic applications. In most cases successful completion of the course will carry a college diploma.

Details of the courses are obtainable from the principals of the following colleges participating in the scheme:—Northern Polytechnic, Holloway Road, London, N.7; Norwood Technical College, Knight's Hill, West Norwood, London, S.E.27; E.M.I. Institutes, Ltd., Pembridge Square, London, W.2; Coventry Technical College, The Butts, Coventry; and Bolton Technical College, Manchester Road, Bolton.

European V.H.F. Broadcasting

PLANS for the assignment of frequencies in the v.h.f. band to European broadcasting stations—both sound and television—were approved by twenty-one countries at the recent meeting in Stockholm. Nine eastern European countries and Portugal were not signatories although they attended the Conference, which was convened in Sweden at the suggestion of the Swedish Telegraph Administration.

At Atlantic City (1947) three bands between 30 and 300 Mc/s were allocated to broadcasting (41-68, 87.5-100 and 174-216) and plans were produced at Stockholm for each of these. Bands 1 and 3 were allotted to television and Band 2 to sound broadcasting. So far as the first band is concerned, the same five channels, each 5Mc/s wide, as used by the B.B.C., have been decided upon. Provision is made in the plan for some 700 European television stations in these two bands.

Plans providing for both a.m. and f.m. stations have been drawn up for the second band, which allows for some 2,000 stations in Europe.

P.T. on Speakers

UNDER an Order* which came into operation on 4th August, loudspeakers and domestic sound and television relay apparatus are now chargeable with purchase tax at the same rate (66⅔ per cent) as radio broadcast receivers.

Although the Order does not differentiate between chassis and cabinet-fitted loudspeakers, it is understood that *any* loudspeaker which can be used with a domestic, car or portable receiver is chargeable.

As this change has been introduced since some of the advertisements in this issue were prepared, we are asked to state that the prices quoted in them may, therefore, be incorrect.

* Purchase Tax (No. 2) Order, 1952.

Televising the Ionosphere

SIR EDWARD APPLETON, and particularly his work on the ionosphere, forms the subject of a 40-minute film which has been produced especially for television and will be seen by viewers on 30th August. Sir Edward, who is now vice-chancellor of Edinburgh University and was for some years secretary (administrative head) of the D.S.I.R., started his research into the existence of the ionosphere whilst in the Cavendish Laboratory, Cambridge, where, from 1919 to 1924, he taught physics under Sir J. J. Thomson. The film includes sequences taken at the radio astronomy experimental station at Jodrell Bank, Cheshire, and at the D.S.I.R. Radio Research Station, Slough, Bucks.

Exporting Flight Simulators

AN order from the Canadian Government for flight simulators for Sabre jet aircraft, amounting to nearly $3,000,000, has been received by Redifon. These flight simulators, which have already been supplied to train crews of the B.O.A.C. Stratocruisers (see *W.W.*, April 1951) produce by electronic means in a grounded replica of a flight deck the various conditions—both normal and abnormal—experienced in the air. The use of flight simulators results in a more thorough training, as with this equipment crews can undertake more hazardous operations.

British Exports

THE total value of the British radio industry's exports for the first six months of the year was £12,169,000—nearly 20 per cent higher than in 1951 despite the fact that June's exports were the lowest since February, 1951. Owing to the introduction of import restrictions in some markets, there was a fall during the second quarter in the exports of domestic receivers, but this was partly made up by the export of components and associated products and capital equipment.

R.I.C. Premiums

PRIZES awarded under the Radio Industry Council's scheme for encouraging technical writing (see *Wireless World*, January issue, p.3) are to be known as R.I.C. Premiums. Up to six of these, of twenty-five guineas each, are to be awarded annually to non-professional authors of articles. A leaflet explaining the scheme has now been issued by the R.I.C., and copies are available at the National Radio Exhibition. To coincide with the Exhibition, an interim award of one 1952 premium is to be made; it is to J. R. Acton for his article "The Single-pulse Dekatron" published in *Electronic Engineering* for February.

Club Directory

Secretaries of many Radio Societies in the United Kingdom keep us informed of Club activities, and therefore changes of addresses, etc., but it would reduce the possibility of error and help us considerably in the compilation of a new Directory of Clubs, which we propose publishing shortly, if secretaries would kindly send us, by the 20th September, the following details:—full name of Society, call sign, whether affiliated to the R.S.G.B., place and frequency of meetings, and name and address of secretary.

Amateur Courses

READERS in metropolitan Essex may like to know that amateur radio evening courses have again been organized by the East London R.S.G.B. group in collaboration with the Essex County Council. They are to be held in the Ilford Literary Institute (High School for Girls), Cranbrook Road, Ilford, from September. The eight-month course of lectures in preparation for taking the Radio Amateurs' Examination will be given on Wednesdays; there is a six-month refresher course for amateurs on Tuesdays, while on Mondays there is a course covering morse and codes of practice. The fee for each course is 10s. Enrolment is from 8th to 12th September.

PERSONALITIES

E. D. Hart, M.A., A.Inst.P., A.M.I.E.E., who recently joined the Equipment Division of Mullards as head of the Technical Department, was for many years with Marconi Instruments and was Technical Editor of *Marconi Instrumentation*. In his new post he will be responsible for technical publications and other technical commercial activities. He is chairman of the Joint Advisory Committee on Radio Communication and Radar Measuring Instruments recently formed by R.C.E.E.A., R.E.C.M.F. and S.I.M.A.

R. R. C. Rankin, O.B.E., A.M.I.E.E., the new technical manager of both Mullard and Mullard Equipment, is responsible for co-ordinating engineering on all types of electronic equipment (both telecommunication and industrial) produced by the companies. He was on the staff of the S.H.A.E.F. Chief Signal Officer at the end of the war, after which he was with Standard Telephones & Cables.

T. E. Goldup, one of the new vice-presidents of the I.E.E., has been a member of the Institution since 1922 and was chairman of the Radio Section for 1943/44. He was appointed to the Radio Research Board of the N.P.L. in 1950, is a Governor of the Ministry of Supply's School of Electronics, Malvern, and a member of a number of advisory bodies. He joined the Mullard organization, of which he is now a director, in 1923.

T. E. GOLDUP, M.I.E.E.

Dr. E. C. S. Megaw, M.B.E., the new chairman of the Radio Section of the I.E.E., has been in the Royal Naval Scientific Service since 1946, prior to which he was for sixteen years in the G.E.C. Research Laboratories. Dr. Megaw, who received his D.Sc. from Queen's University, Belfast, is director of physical research at the Admiralty.

Dr. E. C. S. MEGAW, M.B.E.

W. E. Miller, M.A. (Cantab.), the president-elect of the British Institution of Radio Engineers for 1952/53, was one of the founder members of the Institute of Wireless Technology (1932)—now the Brit. I.R.E. On leaving Cambridge University in 1924, he went to the Cambridge Instrument Co. for a short while before joining the editorial staff of *Wireless & Electrical Trader*, of which he was technical editor (1926-40) and is now editor. He is the author of a number of radio books, including "Radio Circuits" and "Television Explained."

H. J. Finden, M.I.E.E., who is responsible for the development and design of electronic instruments in the Plessey Co, is to read a paper on "Developments in Frequency Synthesis" at the conference on instruments and measurements to be held in Stockholm from 22nd to 25th September.

D. Thomson, whose lectures and demonstrations of L.P. recording are well known to London B.S.R.A. members, has now taken an appointment with Duwe (Wholesale), Ltd., in Manchester, where he will continue to keep in touch with the Association through the newly formed North West Centre.

P. V. Hunter, C.B.E., Hon. M.I.E.E., has resigned the deputy-chairmanship of B.I. Callender's Cables but will continue on the boards of several of the subsidiary companies in the group, which includes British Telecommunications Research, T.C.C. and United Insulator Co.

OUR AUTHORS

S. W. Amos, co-author of the article "F.M. Feeder Unit" in this issue, graduated from Birmingham University with a B.Sc. (Hons.) degree in physics in 1936 and, after four years as a teacher, joined the B.B.C. as a maintenance engineer. In 1943 he was appointed lecturer at the B.B.C. Engineering Training School and then transferred to the technical instruction section dealing first with a.f. subjects and latterly with television. He is, of course, a frequent contributor to *Wireless World* and co-author of the book "Radio Receivers and Transmitters" and the B.B.C. Engineering Training Manual "Sound Recording and Reproduction" which we recently published.

G. G. Johnstone, who, with S. W. Amos, contributes the article on page 334, graduated from King's College, London University, as B.Sc. in 1945. He was in the Technical Publications Section of the Ministry of Aircraft Production, dealing mainly with telegraphic equipment, prior to joining the B.B.C. in 1948 as an engineer in the Outside Broadcasting section. He recently entered the Engineering Training Department as instruction writer and has been engaged on automatic monitors, unattended transmitters and television transmitters.

R. T. Lovelock, contributor of the article on noise limiters for television sound in this issue, transferred from the G.E.C. Telephone Works to the company's radio laboratories in 1932 and assumed responsibility for the design and maintenance of measuring equipment. Since 1936 he has been responsible for both measuring gear and the reliability testing of components and materials. Mr. Lovelock is also concerned with the development of valve application circuits. He has represented the G.E.C. on several R.I. Council technical committees and B.S.I. committees.

W. E. MILLER, M.A. (Cantab.).
(See centre column.)

A. H. B. Walker, who contributes the article "Variable H.T. Power Pack" in this issue, joined the Rectifier Engineering Dept., of Westinghouse, after graduating B.Sc. in 1934. Four years later he transferred to the company's research laboratory and was associated with the development of the "Westat" constant potential rectifier and the "Stabilistor" a.c. voltage stabilizer which he described, respectively, in our April 1940 and November 1944 issues. He has also been concerned with the development of copper oxide, selenium and germanium rectifiers. Since 1949 he has been deputy-chief of the Westinghouse Research Laboratory.

P. J. Walker, who, with D. T. N. Williamson, contributes the article "Amplifiers and Superlatives" in this issue, has been responsible for most of the design and development of audio equipment made by the Acoustical Manufacturing Co. (Huntingdon), which

he founded in 1936. He is well known as a lecturer on loudspeakers and high-quality reproduction in the home.

IN BRIEF

Television licences in the United Kingdom increased during the first six months of this year by 357,350, bringing the total at the end of June to 1,538,550. The total number of receiving licences at 30th June—including television and 145,000 for receivers fitted in cars—was 12,748,000.

I.E.E. Council.—Among the new members of the Council of the I.E.E. who take office on 30th September are Dr. C. Dannatt (director of research and education, Metropolitan-Vickers), O. W. Humphreys (director, G.E.C. Research Laboratories), A. H. Mumford (asst. engineer-in-chief G.P.O.), Prof. M. G. Say (professor of electrical engineering, Heriot Watt College, Edinburgh) and H. R. L. Lamont (senior lecturer in electronics, Dept. of Electrical Engineering, Royal Technical College, Glasgow).

I.E.E. Radio Section.—The following have been elected to fill the vacancies which occur on the Radio Section Committee of the I.E.E. on 30th September: Dr. E. C. S. Megaw (director of physical research, Admiralty) chairman; C. W. Oatley (Engineering Laboratory, Cambridge University) vice-chairman; N. R. Bligh (G.E.C. Research Laboratories), J. H. H. Merriman (G.P.O. Radio Planning Branch), Brig. E. J. H. Moppett (Pye Telecommunications), Dr. A. R. A. Rendall (B.B.C. Designs Dept.), and Dr. J. A. Saxton (Radio Division, N.P.L.) ordinary members. To fill the vacancy caused by the election of C. W. Oatley as vice-chairman before the completion of his term of office as an ordinary member of the Committee, G. G. Macfarlane (T.R.E. Malvern), has been co-opted.

German Patents.—We have been advised by the City Librarian, Leeds, that German patent specifications are again being received in the Library of Commerce and Technology, and the first consignment, Nos. 800,001-815,938, arrived in June. Although those issued during the war (678,144-800,000) are not available, there is an arrangement with the Patent Office, London, whereby photostat copies of individual patents can be obtained. The practice of lending specifications to libraries and industrial organizations outside the City is being continued.

Prospectuses covering the full-time and part-time courses at the Norwood Technical College, Knight's Hill, London, S.E.27, and the S.E. London Technical College, Lewisham Way, London, S.E.4, include details of courses in telecommunication engineering, radio and television servicing, radar and u.h.f. techniques.

Guided Missiles.—All the main information now available on the development of guided weapons in Britain, the United States, Germany, the U.S.S.R. and elsewhere, is presented factually in "Development of the Guided Missile," by Kenneth W. Gatland, recently published for *Flight* by Iliffe & Sons (price 10s 6d).

"Television Oscilloscope."—An error occurred in the circuit diagram of this instrument (Fig. 5, p. 280 of the July issue). The screen feed resistor R$_{11}$ was shown as 150 kΩ instead of 40 kΩ.

R.I.C. SYMBOL—A winged lion rampant surmounts the globe on the six-colour poster advertising the Earls Court Exhibition.

High Power from Kirk o'Shotts.—The high-power television transmitter at Kirk o'Shotts, which was supplied by Emitron Television and is capable of delivering a peak power of 75 kW into the aerial, was brought into service on 17th August. It replaces the low-power standby transmitter which has been in use temporarily since the Scottish station was opened in May.

Electro-physiologists and others concerned with the recording of low-frequency phenomena are invited to the meeting of the Electro-Physiological Technologists' Association at Hurstwood Park Hospital, Haywards Heath, Sussex, on 20th September at 10.30 a.m. when a number of papers and demonstrations of special interest will be given. Readers are asked to write to the Secretary, G. Johnson, at the above address, intimating their intention of attending.

B.S.R.A. Manchester.—A lecture-demonstration on tape recorders will be given by Salford Electrical Instruments to members of the Manchester Centre of the B.S.R.A. at the Engineers' Club, Albert Square, Manchester, on 22nd September at 7.30.

B.S.R.A. Portsmouth.—At the meeting of the Portsmouth Centre of the B.S.R.A. at 7.30 on September 11th in the Guildhall Central Library, G. H. Hornsby and P. O. Sharpe will speak on "The Marriage of L.P. with *ffrr*."

Amateur Exhibition.—The sixth annual amateur radio exhibition, organized by the R.S.G.B., will be opened at the Royal Hotel, Woburn Place, London, W.C.1, by Sir Ian Fraser, C.B.E., M.P.—a past-president of the Society—at 12 noon on 26th November. The show will remain open until 29th November.

Glasgow Show.—Scottish retailers are staging a radio and television exhibition in the St. Andrew's Hall, Glasgow, from 22nd to 27th September.

Amateur Television.—Six members of the Television Society have undertaken to design and construct the various units for the Society's 10-W television transmitter which will operate on B.B.C. standards on 427 Mc/s (vision) and 423.5 Mc/s (sound). It is expected to be completed in October.

Institute of Physics.—The 32nd annual report of the Institute for 1951 records an increase of 222 in the membership, making the total 4,080. At the annual general meeting O. W. Humphreys (director, G. E. C. Research Laboratories) was elected a vice-president and Dr. S. Whitehead (director, British Electrical and Allied Industries Research Assoc.) honorary treasurer.

Sponsored Television.—Associated Broadcasting Development Company is the title adopted for the new company recently formed to promote sponsored television in this country. The directors include Sir Alexander Aikman (chairman of E.M.I.), Norman Collins (chairman of High-Definition Films), Sir Robert Renwick (president, R.E.C.M.F.) and C. O. Stanley (chairman of Pye).

Pye's technical director, B. J. Edwards, and export director, P. M. Threlfall, recently flew to Bangkok, Siam, to supervise a demonstration of Pye television transmitting and receiving equipment which had been flown out a few days earlier. It was the first television demonstration in the country and aroused great enthusiasm.

R.F. Heating.—Parties of up to 30 senior engineering students from technical colleges and research establishments are invited by Wild-Barfield Electric Furnaces to tour the production shop, metallurgical and chemical laboratories and the furnace development section of their works at Watford. Particulars of the tours, which will be conducted on weekday afternoons from 1st September to 31st May, are obtainable from Elecfurn Works, Watford By-Pass, Watford, Herts.

Underwater Television.—Rees Mace Marine is contemplating offering a complete Pye underwater television installation, similar to that recently installed on H.M.S. *Reclaim*, for hire to ship owners, harbour boards, salvage and insurance companies and has circularized over sixty of these organizations in this country to ascertain their reactions.

NEW ADDRESSES

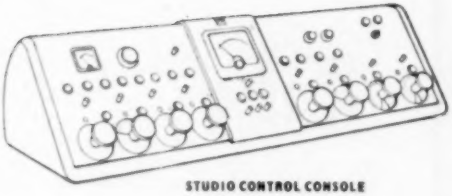
Decca.—The telephone numbers of the Decca Companies at 1-3, Brixton Road, London, S.W.9, have been changed from Reliance 3311 and 4211 to Reliance 8111.

Ediswan.—The Birmingham Office of Edison Swan Electric Co. is now at Swan House, 10, Hospital Street, Birmingham, 19. (Tel.: Central 6411/2.)

Addison Electric Co. has moved from 163, Holland Park Avenue, London, W.11, to Bosworth Road, London, W.10 (Tel.: Ladbroke 4280).

Pennine Amplifiers' new address is Page Street Works, Back Page Street, Huddersfield, Yorks. (Tel.: Huddersfield 5145).

Industrial Electronics, manufacturing and consulting engineers of 99, Gray's Inn Road, London, W.C.1 (Tel.: Holborn 9873/4), have opened a factory at Magnet Works, Derby Road, East Sheen, London, S.W.14. The London Office will remain at Gray's Inn Road.



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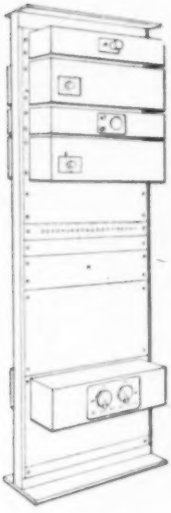

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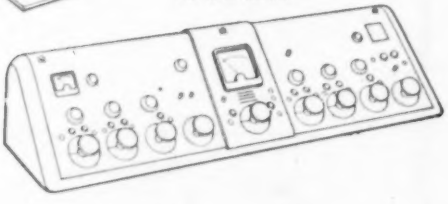
CONTINUITY CONTROL DESK
to provide broadcast continuity from several studios and O.B. sources.



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INFORMATION THEORY

By "CATHODE RAY"

It is a very inconvenient habit of kittens (Alice had once made the remark) that, whatever you say to them, they *always* purr, 'If they would only purr for "yes" and mew for "no," or any rule of that sort,' she had said, 'so that one could keep up a conversation! But how *can* you talk with a person if they always say the same thing?' ("Through the Looking Glass")

FOR some years the higher-brow journals have been carrying learned papers on the Theory of Information. This month a Symposium on it is being held at the I.E.E., and it may possibly even be mentioned in newspapers. If so, I can hardly wait to see what they make of it; for it tends to bear one swiftly out of one's depth in profound philosophical waters. But of course all new ideas seem strange and difficult at first. The important thing is that information theory is stimulating progress on a great number of different fronts at the same time. One of them is our own subject of communications; in fact, information theory grew out of communication theory. Now it has got itself mixed up with electronic computors, mathematics, the theory of games, the workings of the brain and nerves, the psychology of the senses, the study of languages, codes and ciphers, thermodynamics, noise, time, the quantum theory, radar, prophecy, and goodness knows what. I even saw an article on the electrical control of dangerous machinery and processes which was based largely on it. Though we may not be interested in all of these things, scientifically inclined readers will no doubt agree that it is time to have at least a rough idea of what this ubiquitous theory of information is.

Measuring Information

In the first place, "theory" mustn't be taken to mean some isolated hypothesis, such as an attempt to explain why the sun doesn't cool down quicker or why the favourite came in last. It means the whole scientific study of "information." And what does "information" mean? In a broad sense it can be described as something which, when received, increases what one knows. To be able to study a thing scientifically, however, one has to be able to measure it. But how can "information" possibly be a subject for such precise treatment as mathematics? How, for instance, could one calculate the numerical ratio between two such pieces of information as "twice two is four" and "Queen Anne is dead"?

Non-scientific people have the same sort of reaction when they are told that energy is a mathematically calculable quantity. "How," they ask, "can you compare the quantities of energy expended in digging a trench and composing a symphony?" We remember[1] that energy, like information, is a thing that crops up in a variety of widely different forms, yet all of them can be precisely evaluated in joules. But to make this possible it was necessary to throw out some of the non-scientific associations of the word. So it is with information. The main thing to be thrown out is what most people find most interesting—its meaning. That may seem rather a drastic cut, but clearly it would be hopeless to measure information scientifically if its meaning were taken into account.

So "information," from now on, will exclude meaning. It is—or should be—a matter of no concern at all to the telegraphist in his official capacity if the telegram he is handling happens to be one arranging for his wife to run away with someone else. His job is not to pay attention to the meaning, but only to see that transmission is unaccompanied by any additions, deletions, or modifications.

Selections from a Code

A great many different systems have been evolved for expressing information. Sometimes each symbol is made to express a whole idea, as in the ancient Egyptian hieroglyphics, which were little pictures, rather like the graphical symbols used in circuit diagrams. That may be all very well within a restricted field such as radio circuit diagrams but a typewriter having a separate symbol for every word in the modern dictionary would be really too much. A logical method would be that attempted in shorthand—a symbol for each vocal sound. Most written languages—and English perhaps most of all—depart from this ideal. But the essential fact to note is that any sort of intelligible "signals," whether vocal, visual, written letters or numbers, code symbols, winks and nods, or what have you, *are selections from a known and agreed list of possibles.* In written English, for example, there is a list of 26 letters. Each letter written is a fresh choice. Seeing then that information is a selection or choice, the most suitable unit of measurement is the simplest possible choice—between two alternatives: yes and no, on and off, heads and tails, 1 and 0. This unit is called the binary digit, now commonly abbreviated to "bit."

I discussed the "bit" some time ago[2] with particular reference to numbers, explaining how the binary system of numbers, though not in general use, has advantages in telecommunication and computors because two opposite alternatives are so much easier to distinguish from one another than the ten symbols (0 to 9) in the

[1] "Energy," *Wireless World*, January, 1952.

[2] "Tens or Twos?" *Wireless World*, Sept., 1951.

common decimal scale, especially when there is severe noise or interference. We also saw how numbers in the decimal or any other scale can be "translated" into bits. The first bit in a series distinguishes between two alternatives, represented by the first parting of the ways starting from the left in Fig. 1. The second bit begins from the choice expressed by the first, so the total result of the two is a choice of 1 from among 2^2 or 4 possibles. The third bit narrows the selection to 1 in 2^3 or 8; the fourth, 2^4 or 16; the fifth, 2^5 or 32; and so on. Looked at the other way round, a choice of 1 from a list of 32 possibles is equal to 5 bits, because any one of 32 can be selected by a series of 5 yes-or-no choices. The mathematical way of saying this is that 5 is the logarithm of 32 to base 2. The principle holds good for all numbers, and can be written:

$$b = \log_2 n$$

where b is the number of bits equal to a choice of one from n alternatives. So a single digit in the decimal scale (it might well be called a dit !) is $\log_2 10$, or about 3¼ bits.

The same principle can be applied to letters, hieroglyphics, or in fact any "information." This is evidently what Alice had in mind when she pointed out that the two alternative signals in her kitten's repertoire were sufficient, if used according to an agreed code, for carrying on an intelligent conversation. That is indeed the foundation of information theory.

How Many Bits ?

An ordinary telegraph is limited to saying "yes" or "no," for at any given moment there are only two alternatives—signal or no signal. So to send information expressed in words it is first necessary to reduce it to these terms. Since information in English is drawn from a list of 26 alternatives, there must be on the average more than one binary digit per letter.

Fig. 1. *One binary digit (or "bit") is the amount of information given by the selection of one from among two. This is represented by the two alternatives branching away from A. The diagram carries the process as far as 5 bits, which is the amount of information given by a selection of one from among 25 = 32. For example, item 14 out of the 32 could be selected by the following series of five up-or-down switching signals—up, down, down, up, down.*

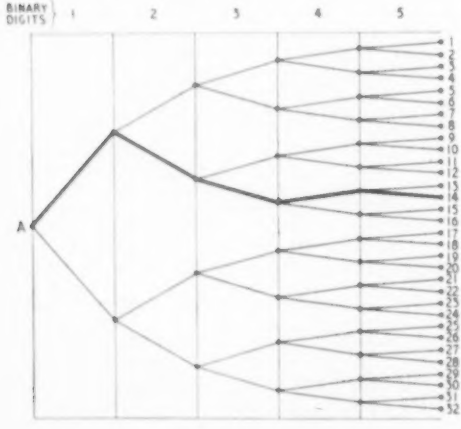


Fig. 1, or the formula just given, shows that 1 in 26 is between 4 and 5 bits. In practice, of course, more than 26 characters are needed, as there are the numerals and punctuation marks and a spacing signal between words, but the same code can be used for both letters and figures if there are two extra spacing signals for changing over from one list to the other. And since one can't have fractions of a bit, the smallest practical number of bits per letter or figure, if all are made the same length, is five, which allows 32 combinations. This is exactly what is done in the Baudot code, Fig. 2. A word of five letters, plus a space, is signalled by $(5+1)5=30$ currents or no-currents; i.e., bits. In the same way one can reckon the information content of any word, sentence, or message.

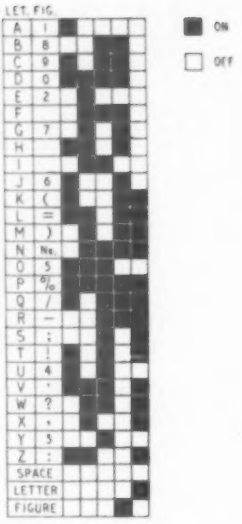


Fig. 2. *The Baudot telegraph code, shown here, is an example of how a series of 5 binary digits can indicate any one from up to 32 letters (or other signs).*

Communication engineers are interested in information theory because they want to make sure that the available channels—telegraph or telephone lines, radio links, etc.—are being used as efficiently as they could be; that is to say, are conveying information at the greatest practicable rate. As the bit is the unit of information, the logical unit for rate of communication, or capacity of a channel, is the bit per second, which I am going to abbreviate to b/s. As we have seen, it is really a measure of the rate at which choices are indicated. In simple line telegraphy a choice is indicated electrically by turning a current on or off; in telephony, by varying its strength in a complicated way; in radio, by varying the amplitude (a.m.) or frequency (f.m.) of a high-frequency a.c. In no case can a series of choices be indicated by an unvarying current, whether d.c. or a.c.

The simplest case would be a system in which a pulse of current stood for one of the choices (1) in a binary scale, and no current for the other (0). On the average, assuming there were no special conditions making either of these two symbols more likely to occur than the other, half the bits would be signalled by current and half by no current, so there would be half as many pulses of current as bits. In other words, the signalling rate in b/s would be twice the average number of current pulses per second.

The pulse frequency would be greatest when the two binary signals occurred alternately, as in Fig. 3. But of course if this condition were permanent there would be no information—a continuous extension of Fig. 3 could be generated locally at the receiving end and the telegraph line wouldn't be needed ! With real signals, the pulse frequency might for a moment be as high as this maximum; at other times an unusu-

ally long succession of symbols of one kind might bring it down close to zero. The frequency would fluctuate randomly between these two limits—zero and half the bit frequency. In short, *a band of frequency is required*, and its width is proportional to the rate of information conveyed. This is roughly what is known as the Hartley Law, from an important paper by R. V. L. Hartley, of U.S.A., published in 1928. In our binary pulse telegraph, then, a bandwidth of p pulses per second is required for a signalling speed of $2p$ bits per second.

In radio (a.m.) it comes to the same thing—the only difference is that the starting point is shifted from zero to some high frequency—the carrier-wave frequency. That is, with the single sideband system. In the usual double sideband system used for broadcasting the frequency band is duplicated, but that is merely for convenience, to simplify the equipment. In f.m. radio, instead of the amplitude the frequency of the carrier wave is varied, and the extent of the variation does not depend on the frequency of signalling. So at first it looked as if the Hartley Law could be got around by making the frequency variation smaller than the modulation frequency. But the mathematicians completely punctured this idea by proving that the bandwidth in f.m. must actually be greater than in a.m., however small the frequency deviation.

If one were to use sharp-cornered pulses as in Fig. 3, the maximum frequency in sine-wave *cycles* per second would be many times greater than the pulse frequency, because of all the harmonics needed to build out the spiv shoulders. But this is a pure luxury; the signals can still be read after they have been considerably rounded off, say by passing them through a low-pass filter. There is a limit to this process, however. A simple way of looking at it is to say that the limit is reached when all the harmonics of the highest pulse frequency have been removed, leaving only the fundamental. Then *pulses* per second in our previous finding become *cycles* per second, and it reduces to the conclusion that a bandwidth of f c/s can pass signals at $2f$ b/s.

Although this result has been arrived at by reasoning that is far from what the mathematicians call rigorous, it is just about right according to the official findings until quite lately. It is in any case a good rough rule. To follow recent developments, however, we shall have to consider the meaning of information more closely.

It is very much bound up with codes. The Baudot illustrates the "bit" idea very nicely, but it was invented for a particular type of telegraph which provided accurate timing of the pulses, and is not convenient for general purposes. What about the Morse code? It can be signalled as a 3-symbol or ternary code—dot, dash, and space—but more often is a binary code in which a dot is regarded as a single "on" and a dash as a succession of three "ons" (Fig. 5). With one "off" between dots and dashes and three "offs" between letters, the number of on-or-off elements per letter varies from four (for E) to sixteen (for J and similar letters), the average being 11¼. The number per figure is considerably greater. Each element is potentially a bit, but would it therefore be fair to say that the information was greater by Morse than by Baudot? Surely one would say that Morse was occupying more channel capacity to send the same real information. You would not consider you had received a ton of timber just because 5 cwt had been loaded so badly that it filled a one-ton lorry. So it is important to distinguish between channel capacity and actual rate of information. If information at 40 b/s is bulked out to occupy a channel with a capacity of 100 b/s, one could say that the efficiency of coding was 40 per cent. It looks as if the efficiency of the Morse code, relative to Baudot, is $5/11\frac{1}{4} = 44.5$ per cent. But this is hardly being fair to Morse, who, to do him justice, though he had probably never heard of information theory, allowed for a most important element in it which we must now consider.

Improbable Bomb Story

The basis of measuring information is really improbability. The more probable a signal, the less information it contains. This may not be particularly obvious at first, due perhaps to the difficulty of thinking of words or other signals apart from their meaning. If so, perhaps the following example will get round it. Suppose a signal were to be used to convey a certain piece of information: the whereabouts of an unexploded bomb on a map divided into squares. If the map were divided into two squares, say A and B, the probability of either being signalled would (in the absence of any other information) be exactly 1 in 2—a fairly high degree of probability. But the information conveyed would be small—it would do no more than direct attention to one half of the whole map. If the map were divided into 26 equal-sized squares lettered A to Z, the probability of any letter being called would be only 1 in 26—less than 4 per cent, compared with 50 per cent in the first case—and the information would be greater. The chance of any particular square in a 1,024-square map being called would be less than 0.1 per cent, and the information would be greater than in either of the previous cases. It would not, however, be 512 times greater than in the two-square signal. By using the Fig. 1 technique, successively halving each area of the map, any one out of 1,024 ($=2^{10}$) squares could be pointed out by a 10-bit signal.

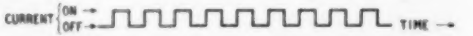


Fig. 3. *The maximum current frequency of binary signals (i.e., current on or off) occurs when all the odd signals are of one kind and all the even signals of the other. An unending sequence of this kind has zero bandwidth and conveys no information.*

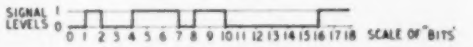


Fig. 4. *An actual signalling sequence is irregular and may contain any frequency from zero to maximum—it occupies a definite bandwidth.*

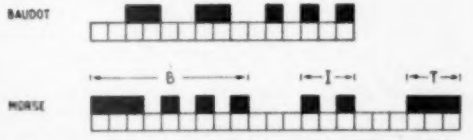


Fig. 5. *Comparative numbers of signal elements (potential "bits") needed in Baudot and Morse codes. To send at the same word speed by Morse would occupy more bandwidth.*

Imagine now that one of the 1,024 squares occupied half the map, the other half being divided equally into the remaining 1,023. A signal that indicated the big square would convey much less information than one disclosing the identity of one of the tiny squares. In fact it couldn't make any difference to the amount of information how many squares the other half was divided into; it would be the same as if there were only a simple choice between two halves, namely 1 bit. Our formula $b = \log_2 n$ is evidently untrue if n means the *number* of alternatives, unless they all happen to be equally probable. The probability of half the map was 1 in 2, or $\frac{1}{2}$, which can be regarded as an *improbability* of 2. If we simply make n mean the improbability, instead of the number of alternatives, the limitation of the formula is removed. The information content of 1 out of a list of 32 equally probable letters is, as we saw, 5 bits; and it would make no difference to this if the other 31 letters were all the same, so that the choice really lay between only two letters, one having an improbability of 32 and the other 32/31.

When the letters in a sufficiently large sample of typical English are counted, it is found that E turns up, on the average, once in every 8 letters. So its information is not 4.7 bits (as it would be if all the letters were equally unlikely to appear) but $\log_2 8 = 3$ bits. If it occurred every time, so that its probability was 1 in 1 (a complete certainty) one would know in advance what letter was coming, and its arrival would bring no information at all. Log $1 = 0$. As Alice remarked, "How *can* you talk with a person if they always say the same thing?" J, on the other hand, averages 1 in 800, so its information rating is $\log_2 800 = 9.65$ bits.

Morse Had the Right Idea

Clearly it is not the best possible information packing system that gives as much time to low-information letters like E as to high-information letters like J, X, and Z. If E and other frequent letters are conveyed by a briefer-than-average symbol, the average length of a message in code is reduced, because the longer-than-average symbols occur so seldom. Ideally, information should be spread evenly over time. So Morse was on the right lines when he represented E, which has the smallest information content of any letter in the English language, by the smallest signal—a single dot. If the average length of a letter in Morse is calculated so as to allow for the relative frequency with which each occurs, it comes down from $11\frac{1}{2}$ bits to 9. That is still nearly twice Baudot, partly because it allows so much margin for inaccurate keying and partly because its basis is theoretically inferior, though practically more adaptable. Even Baudot is not theoretically perfect, except for coding 32 equally probable symbols.

So long as measurement of information was based on the assumption that all the n symbols in an agreed list were equally likely to be used, our $\log_2 n$ formula was something quite definite to build on. But now we have brought in this question of probability our foundations seem to have given place to the shifting sands of chance. The table showing that Z occurs less often in English than once per 1,000 letters would be quite unreliable if applied to an article on zebras or zinc.

So the relative probability of letters in English is more complicated than just making a table showing how many of each occur, on a wide average, per 1,000. To assess the information value of any particular occurrence of a letter it is necessary to take account of what has gone before it. While in general the odds are 40 to 1 against a U, if the previous letter happens to be a Q they become heavily on. So the theoretically ideal code would be continually reviewing the odds as the message went along, and adjusting the lengths of the symbols accordingly. This appears to be quite impracticable, but as we shall see presently it is an important idea.

Errors from Noise

So far we have been considering only binary signals. But of course one could work in decimals—which would be particularly convenient for numbers—or even in a scale of 26 or more for letters. The signals could be distinguished from one another by amplitude, or frequency, or in some other way. If dots were formed in 32 different amplitudes, then every dot could signal a whole letter or other symbol—5 bits per dot instead of only 1. In principle it might seem that there was no limit to the rate at which information could be signalled; it was only a matter of identifying sufficient different amplitudes. But that would be forgetting about noise and other interference, which introduces an element of uncertainty into reception by adding to some amplitudes and subtracting from others. With a binary code, noise has to compete with the full power of the transmitter every time, and if that came in much above the average noise level, the risk of failing to identify any digit in a message would be very small. There is always *some* risk, because "white" or random noise has occasional peaks many times its average level, but the risk falls off very rapidly indeed as the signal/noise ratio is increased (Fig. 6). With a signal 30 times mean noise amplitude (nearly 30 db) the risk would be utterly negligible. One could change over to a scale of 4, as in Fig. 7, and still have a tenfold amplitude margin (20 db) for distinguishing one from another. Since each digit now indicates a selection from 4 possibles, it is equal to 2 bits, and the rate of signalling is doubled. But if one were to use a 32-scale code, each

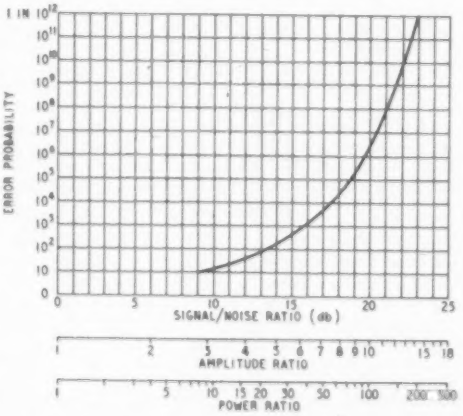


Fig. 6. *Showing how risk of errors due to noise varies with signal/noise ratio, using p.c.m. signalling.*

signal step would be no more than average noise amplitude, and the proportion of errors would be so large as to wipe out the advantage of higher speed.

One fact that emerges from this is that the capacity of a channel to transmit information depends not only on its bandwidth, as in the Hartley Law, but also on signal/noise ratio. Since noise cannot be reduced below a certain minimum level,[1] this means transmitter power. One can send more information through a channel of given bandwidth by increasing the power, *provided that the code is suitably adapted*. But it works out that a very large power increase is needed to gain any worthwhile increase in signalling speed (or reduction in bandwidth for the same speed). Suppose it is agreed that a margin of 20 db (10 times amplitude) is necessary to ensure the desired standard of accuracy. Changing from binary to scale-of-4 coding doubles the speed but means increasing the minimum adequate signal amplitude threefold (Fig. 7), or 9 times the power. Doubling the speed again can be done by using a scale of 16, which requires 15 times the original amplitude and 225 times the power. So there are severe practical limits in this direction. The reason for the steep rise in power is our basic fact that the amount of information in a signal is (with equally improbable symbols) equal to the *logarithm* of the number of different symbols, which with the kind of coding we are considering is one plus the number of distinguishable signal levels. Numbers increase out of all proportion to their logs.

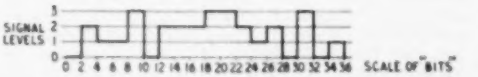
Can we find a formula for the maximum possible rate of signalling information? We can certainly do so if we continue to assume this particular sort of coding (which, incidentally, is called p.c.m.[2]) and a particular error risk, say 1 in 1,000 million—or 1 in a million million if you like; as Fig. 6 shows, it doesn't make much difference to the required signal/noise ratio. But the object of information theory is not to find a formula for what we know we can do already, but for the ultimate perfection with which to compare present and prospective systems. We have already seen that the proviso "with equally improbable symbols" limits what can be done, because symbols are not equally improbable, and this offers scope for abbreviating the code. Some have so little improbability that they can easily be guessed; U after Q, for example.

Redundancy

When we send a telegram, we usually cut out quite a lot of words that we would write in a letter to say the same thing. Even in such a laconic communication as "Coming home Saturday" there is a certain amount of padding. If it were mutilated in transit and arrived as "Comi hom Satday" the recipient (unless unusually dim) would receive just as much real information. The experts have a word for this characteristic that enables some of the signals to be lost without loss of information—redundancy. This word has a nasty sound, but it can be quite helpful in enabling one to make good the losses in transit. The G.P.O. ought to be particularly grateful to it, for without redundancy their telephone system would be worth very little. I once phoned a friend and asked him to write down what I said, which was "I faw your thotograth in the newftater ve uvver bay." I need

[1] "Noise," *Wireless World*, May and June, 1952.
[2] "P.C.M.," Thomas Roddam, *Wireless World*, March, 1949.

Fig. 7. *Where the peak signal strength is sufficiently above noise level, it is possible to distinguish more than two different levels, as here. But the signalling capacity is not nearly proportional to the signal power required.*



hardly tell you what he wrote—you can guess the message of which I uttered a distortion. Many pairs of consonants cannot be distinguished over the phone, and if there weren't a good deal of redundancy in ordinary language it would be impossible to reconstruct the messages being spoken. The amount of redundancy varies with the type of message; if we were phoning a chemical formula, in which redundancy would approach zero, it would be necessary to create some, by saying "F as in Freddie," etc., in order to get it across without fear of error.

Shannon's Formula

Now a very interesting result of information theory, due mainly to C. E. Shannon of U.S.A., is that the error risk can be made as small as one likes by using a sufficiently elaborate code, retaining only enough redundancy to offset noise; and that there is a definite theoretical limit to the information rate in b/s, beyond which no imaginable or even unimaginable code can go. The actual formula for it is surprisingly simple:

$$f \log_2(1+N)$$

where f is the frequency bandwidth and N the signal/noise power ratio. The $\log_2(1+N)$ takes the place of 2 in the Hartley-type formula, which is actually correct when $N=3$. Using any known practical code with such a small signal/noise ratio, there would be too many errors. In theory it is possible to make the error rate negligible, but only by using an extremely elaborate coding and decoding, which would use up at lot of time.

One of the conclusions is that p.c.m is perhaps nearer to the ideal than any other yet put into practice. And it has the great advantage that it can be used not only for telegraphy but for telephony or any other waveform—in fact that is its main purpose, as explained in Thomas Roddam's article just referred to, and in my "Tens or Twos?" Although speech currents look as if they have a continuously varying waveform, in practice the effect of noise is to prevent more than a limited number of different levels being distinguished at the receiver; that being so, the waveforms can be broken down into code formations like Fig. 7, and the same principles apply as for telegraphy, semaphore waving, or any other code signals.

But it is important to be clear about what is the information to be transmitted. In speech, is it the words spoken, or is it the sounds of the words? If just the words, then waveform telephony is an exceedingly inefficient method of signalling them. The vowel "ee," a very simple frequently occurring sound, and therefore having a low information rating, occupies the channel with hundreds of cycles of a.c.; whereas in telegraphy one or two would be enough. The consonant "th," also very common, necessitates a large bandwidth if it is to be clearly distinguished from "f." It is possible to use a channel of the same bandwidth to send the words by telegraphy many times faster than they could be spoken. But if the

information to be transmitted includes tone of voice, giving recognition of the speaker, and emotional characteristics, and, in music, the sound of an actual performance rather than merely the score, that's different. Even so, it is possible to economize. The ingenious Vocoder[1] economizes very considerably by sending not the actual sound waveforms themselves but only signals needed to switch on generators of those sounds at the receiving end whenever they are uttered by the speaker. Although the result is admittedly not equal to telephony at its best it gives recognizability of speakers' voices, using only a fraction of the usual frequency band.

One hopes now that information theory is going to be a help in dealing with that most wildly extravagant of all telecommunications—television.

[1] "Channels of Communications," *Wireless World*, July, 1947.

New Electronic Organ

Methods of Tone Generations Used in the "Gregorian" Instrument

BUILT to meet the requirements of organists whose standards of tone equality and general performance are those of the traditional pipe organ, the new "Gregorian" instrument recently demonstrated in London is a joint production of Alfred E. Davies and Son, organ builders, of Northampton, and the Acoustical Manufacturing Company of Huntingdon.

The simulation of organ tone by electronic generators is an intriguing problem, involving as it does the control of build-up and decay times, as well as harmonic content —not to mention the introduction of prefatory wind noises in the case of some stops—which all help to make the organist feel really at home, and not at the keyboard of some strange new electro-mechanical instrument. Mr. P. J. Walker, whose interest in traditional organs is of as long standing as his interest in high-quality reproduction, has for many years been working on this problem, and privileged visitors to the works at Huntingdon have from time to time been invited to play or to criticize a succession of prototypes. It is now felt that the results can be offered for general criticism by organists, and that if there are criticisms that they can be met.

Among organists themselves there is no unanimity as to what constitutes, for example, diapason tone; judgment is inevitably a personal matter compounded of taste and experience. To meet this range of preference, interchangeable plug-in filter units are provided in the "Gregorian," so that an instantaneous change to other tone colours can be made until the customer is satisfied. In addition, each basic note in the 96-valve generator can be individually "voiced."

The tone generators are L-C controlled oscillators from which the fundamental and harmonics are drawn separately from different parts of the circuit. Build-up and decay times are controlled by a third winding on the iron-cored coupled circuits which control the effective Q of the tuned winding. Wind noises are simulated by the deliberate introduction of random circuit hiss during the build-up period. Tremolo is effected by varying the h.t. supply to all generators above the F♯ below middle C.

Electronic methods are not relied upon exclusively for the generation of authentic organ tone. The associated loudspeakers are not "reproducers" in the accepted sense, but are mounted in pipe-like baffles constructed of woods chosen for their "resonant" qualities—using the term this time in its musical context.

The effect as a whole is most pleasing, and although professional organists may be expected to express the usual divergence of opinion, it is safe to say that their audiences will not be conscious that the organ tones are of electrical origin.

With two manuals, pedal, and choice of eight stops from a comprehensive list to suit the acoustics of the auditorium, the price is £1,460, ex works. A smaller specification with five stops is available.

50-WATT V.H.F. TRANSMITTER

PRELIMINARY information is now available of a new Pye 50-watt v.h.f. transmitter which is designed for telephony operation in the band 60-184 Mc/s. It is crystal-controlled with a frequency tolerance of ±0.003 per cent. Harmonic suppression is said to be better than 50 db. High-level amplitude modulation is used with a modulation capacity of 100 per cent. It operates from single-phase a.c. mains of standard voltages and frequency and on full modulation consumes 585 VA.

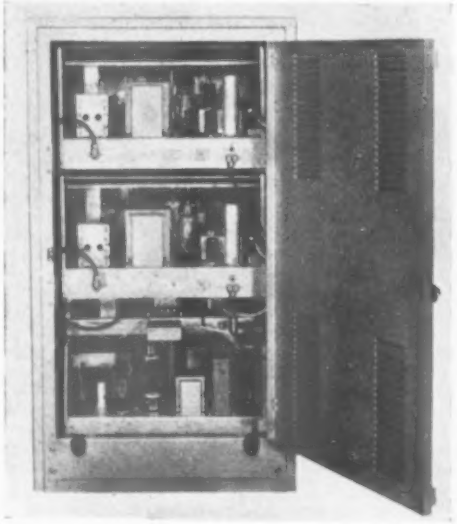
The standard equipment comprises two units, (a) r.f. and modulator and (b) power unit. These are mounted one above the other and interconnected by cable and a 12-way plug and socket. When assembled in a standard 19-in rack the overall height of the two units is 19½ in and the maximum depth 10 in.

Various alternative assemblies are possible to meet special requirements and one such is shown in the illustration, where is seen the rear view of two transmitter units mounted in one of the latest Pye enclosed cabinets together with a power unit below.

Provision is made in the transmitter for switching to any one of six ordinary crystals or to four temperature-controlled units, and re-alignment of the circuits can be effected in under 30 seconds.

The equipment may be remotely controlled over a single pair of telephone lines up to a distance of 15 miles. The makers are Pye Telecommunications, Ltd., Newmarket Road, Cambridge.

Two Pye 50-watt v.h.f. transmitter units mounted in an enclosed-type cabinet with power unit below.



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A feature of the instrument is that the frequency modulation of the carrier injected into the receiver is carried out electronically, the X-sweep voltage of the oscillograph being used to control this modulation. The response curves of R.F. and I.F. tuned circuits are displayed on the oscillograph producing the sweep voltage, the 7 megacycles bandwidth of the F.M. sweep occupying the entire length of the trace. The carrier of the 'Tele-Check' can be set to any frequency between 7 and 70 megacycles.

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Progress in Amateur Television

Review of Current Activities and Techniques

By M. BARLOW* (G3CVO)

THE recent successful two-way television contact between the amateur television stations G5ZT/T and G3BLV/A/T at Plymouth was another milestone in the history of post-war amateur television transmission. Readers of *Wireless World* will remember various notes concerning the activities of G2DUS/T and other members of the British Amateur Television Club. During the four years of its life this Club has fostered considerable interest in the peculiar problems associated with amateur picture transmission, and it numbers amongst its members many of the leading names in amateur radio and television.

Before the war many people built various forms of disc scanners, but it was not until the influx of ex-Government radar equipment after the war that any progress was made with electronic systems. After spasmodic efforts to contact other experimenters working along the same lines, a small group of enthusiasts began to publicize the idea in the lay press and the amateur magazines. In the early days, G2DUS possessed the only camera tube, and the remainder of the amateurs were forced to use "telestill" and telecine equipment working on the flying-spot scanning system with "surplus" radar cathode ray tubes for scanning. Results were surprisingly good, and since then considerable improvements have been made. It is now quite possible to obtain resolution equivalent to a 3-Mc/s bandwidth, with good contrast range, on this type of transmission, using a minimum of components and for a total outlay of about £15.

With the emphasis on economy in money and materials rather than long-term reliability, several short cuts have been made, and several truly amateur —rather Heath Robinson—forms of construction have been tried out. Naturally, shortage of suitable components has been a hold-up. The once plentiful RCA 931A photocell is now scarce, and expensive (by amateur standards) at 30s. There is no substitute available. Scanning tubes should be blue, short-persistence types; some of the ex-Government double layer types have to be used instead. There are no really suitable scanning tubes available, either "surplus" or as manufacturers' rejects. Some of the newer types of counter tubes, for instance, would be ideal for divider chains, but are unobtainable or too expensive. On the r.f. side, suitable valves for transmitters are very scarce, and indeed have only just come into use at all. The main trouble, however, is the shortage of camera tubes. Until the latest currency restrictions, RCA 5527 iconoscopes could be readily imported at a cost of about £30, a price comparing favourably with the average amateur communications receiver. These tubes are insensitive and have their faults, but for amateur use they are ideal, being electrostatically deflected and linear in construction, so doing away at once with most of the complicated camera scanning circuits. Pending the arrival of a similar British tube, camera progress has been rather erratic, although some twenty-five assorted tubes are now in use by B.A.T.C. members. Amongst these is a 5527 acquired for 30s in Lisle Street and apparently in perfect condition!

Camera built by K. A. J. Russell of Bournemouth. It uses an RCA 5527 iconoscope pick-up tube working on 250 lines (non-interlaced) and contains a pre-amplifier, a line amplifier and a viewfinder.

Live reproduction without the use of a camera tube has received much attention, and it has been found that by using a true flying-spot system, and scanning

Television picture obtained with Mr. Russell's camera (see above). The subject, an advertisement photo, was illuminated by two 500-watt photoflood bulbs and this picture was taken from the screen of a 9-in monitor tube.

* Hon. Secretary, British Amateur Television Club.

with a 5FP7 or some projection tube, fair results can be obtained. The method is recommended to the amateur who wishes to televise himself at little expense and without occupying too much space. The "studio" is in darkness or faint red light, the blue sensitivity of the photocell providing sufficient discrimination. Using ex-R.A.F. camera lenses, a 5FP7 running at 6 kV will scan an area of some four feet square with about 4-in depth of focus, which is quite sufficient for elementary experiments.

For transmitting cine film (usually 16-mm of great antiquity!) the favoured method is to run the film through the scanner continuously at 25 pictures per second and to scan it with two 50-c/s rasters one above the other, the direction of scan being opposite to the film motion. Extremely good results have been obtained by G. Short and F. Rose (G3BLV), but the system is not too popular in the amateur world owing to the shortage of suitable film material.

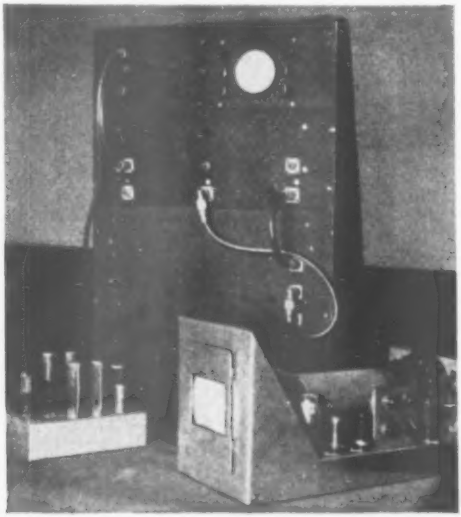
The real stand-by of all amateur television enthusiasts is the telestill unit, capable of transmitting small transparent pictures. Quite good results can be obtained with very simple equipment; for instance, by using a "surplus" ACR1 5-in electrostatic scanning tube and strapping it in parallel with a VCR97 monitor, two EF50s will provide a common time base and also flyback suppression pulses. One photocell and a three-stage video amplifier, with a phase inverter stage for transmitting either positive or negative transparencies, completes the outfit, and at a cost that is distinctly encouraging to those of us who count the money available in shillings and pence rather than pounds. With this unit as a basis, improvements can quickly be made: the addition of a lens system permits the use of 35-mm film strips or 2in × 2in slides; the use of the family television set as a monitor requires the building of a sync pulse generator, but to begin with the original transitron time bases will provide quite sufficient synchronization from their screen grids; a scanning tube with magnetic deflection (such as the 5FP7) will reduce the noise generated because of its finer face-grain. Altogether some 65 telestill units are in operation in this country at the moment.

It is in the more advanced realms of television that the limitations of "surplus" equipment begin to be felt. There are two members carrying out research into colour television, and one trying stereoscopic television. When one remembers that the only suitable photocell is very blue-sensitive and almost totally insensitive to red, and that the only available short-persistence scanning tubes have either a blue trace or a coarse-grained screen, the elementary snags appear at once. Nevertheless, results have been encouraging with the revolving colour-wheel system that is being used. Converted magslips do the driving, while the actual colour filters are cut from cellulose acetate sheet designed for stage lights. Polaroid inserts are used in the stereoscopic units, the viewer having to wear spectacles.

On the radio side, progress has been much slower. Although Dutch amateurs have been transmitting television pictures since 1948 and there are now four amateur stations in the Netherlands, besides some 16 stations in 11 other countries, it was not until 1951 that the Post Office announced the release of vision transmission licences in this country. Unfortunately, initial permission only covered the 3-, 6-, 13- and 25-centimetre bands, all virtually unbroken ground even for amateur *sound* transmission; later the 70-cm band was also released for use. Furthermore, a charge of £3 per annum is asked for the vision permit, in addition to the £2 10s of the normal sound transmitting fee. As a result, the great majority of the television experimenters in this country are forced to carry out their experiments over a closed circuit, and it is noticeable that this branch of amateur radio

Camera built by B. Cedergvist of Helsinki. It contains an RCA 5527 pick-up tube and an amplifier using miniature valves. The deflection circuits for the pick-up tube are housed in a separate unit.

Flying-spot scanner and control equipment used by F. Rose in the recent two-way television contact at Plymouth. On the left is the photocell and its amplifier and on the right is the scanning unit.



appeals particularly to those non-transmitting constructors of an inventive turn of mind. Considerable work is being done with the aim of putting several television stations on the 70-cm band, but these will be for purely experimental communication purposes only. Again, lack of suitable valves is delaying matters.

Circuits.—Video amplifiers tend to ignore peaking coils because of the difficulty of adjusting them correctly without proper test gear. R-C correcting networks are popular instead. A band-pass of 3 Mc/s is usually aimed for. Pulse generators vary enormously, from the simple two-valve arrangement already mentioned to much more complex interlace circuits. Normal standards employed for closed-circuit use are 200-300 lines, 50 pictures per second sequential scan, or 405-625 lines, double interlace. For the sequential scans of a more complex variety, crystal control is common, followed by a simple frequency divider and pulse generator. A normal B.B.C.-type waveform is aimed at, although the precise values vary owing to the lack of accurate test gear. Both blanking and sync pulses are used in more complex equipment, although these are the same thing in simpler apparatus. Where interlacing is used the divider chain has been a source of much bother. Stabilized multivibrators are preferred to phantastron or step counter circuits, a discriminator being used to beat the locally generated 50 c/s against the mains to provide a correction voltage for the master oscillator. Pulse mixing and vision-sync mixing are done either by injecting on different electrodes of the same valve, or by common-load mixing with two valves. Modulators are very experimental, owing to the peculiar difficulties associated with the 70-cm band. Power supplies are regulated for all units. Radio-frequency and ringing-choke e.h.t. systems, not to mention the sound and vision transmitters, are apt to generate annoying patterns, and B.B.C. programmes on medium waves can appear on the camera channel!

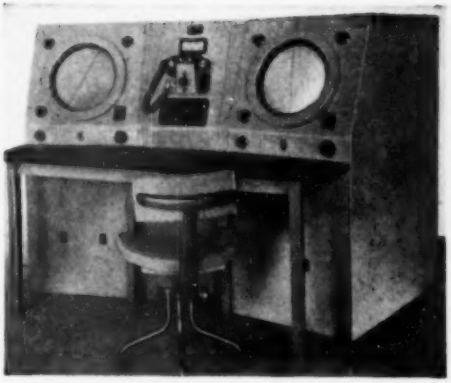
It is hoped that this brief account of the work being done in this country will be of interest. To those readers who are professionally engaged in television work and perhaps a little inclined to scoff, we suggest that they see what *they* can do using only "surplus" goods and very little test gear!

Comprehensive Airfield Radar

RADAR equipment operating in the 3-cm band has been developed by Cossor Radar to meet the needs of airfields requiring a comprehensive control-of-approach aid at a reasonable price. It is claimed that the equipment provides for complete supervision of all aircraft within a radius of 20 miles, and all movement of aircraft on the runways. It also enables aircraft to be brought down through cloud to make a safe landing when visibility is limited to about half a mile. It can be used as static or as mobile equipment.

The control console, shown in the illustration, has, normally, two 15-in cathode ray tubes for the P.P.I. display. One can be used to cover a range of four to five miles and the other to extend the coverage up to the maximum of about 20 miles.

Good range discrimination is obtained by using pulses of 0.1 μsec duration, while undesirable ground echoes are kept down to a minimum by using an aerial system giving a beam of 0.7 deg in the horizontal plane and 3.5 deg in the vertical. The aerial can be tilted to direct the beam at elevations between 0 and 12 deg, the angle of tilt being controlled from the display console.



Console of Cossor airfield radar equipment showing twin 15-in display tubes and radio telephone panel between them.

Large aircraft can be detected at 20 miles or more and smaller ones at 10 miles, and it is possible to follow an aircraft to within half a mile of the airfield.

The aerial system, or scanner, is a paraboloidal reflector measuring 12ft × 3ft and normally rotates at 20 r.p.m. It is fed by a waveguide which can be up to 30ft in length. The transmitter peak power is about 40 kW and it is operated from a 180-V, 500-c/s supply generated by a motor alternator which can be operated from standard mains supplies.

Radio telephone facilities can be provided at the control console when required.

New All-wave Aerial

BY employing wide-band transformers wound on Ferroxcube cores a new interference reducing aerial system has been introduced by Antiference for which a number of interesting features is claimed. Over a range of 100 kc/s to 30 Mc/s, and using a screened twin-feeder between aerial and receiver transformers, the insertion loss is said not to exceed 6 db at any part of the band. Another is the entire absence of resonances, which ensures that the tuning of the receiver's input circuit is not disturbed by changes in aerial reactance so that the ganging holds over the whole range of frequencies covered.

The balanced feeder, used in conjunction with transformers having a high coefficient of coupling between the halves of the low-impedance windings, is said to ensure maximum rejection of longitudinal or "parallel" noise currents.

The versatility of this new aerial is exemplified by the fact that it has been found possible to provide adequate inductance in the transformers to ensure a satisfactory performance with receivers having high-impedance input circuits, as found in certain Continental receivers.

Despite the comparatively high primary inductance provided, leakage inductance in the transformers is surprisingly low, an insertion loss figure of 2.5 db at 30 Mc/s being claimed for a single transformer.

Transformer windings are impregnated to ensure stability of performance in all conditions of weather and in all climates. They are housed in watertight containers.

The new "Exstat" aerial is available in several different forms allowing for the use of horizontal or vertical wires or rods and there is also a composite system in which the mast supporting an H- or X-type television aerial is used as an anti-interference aerial for broadcast reception, in addition to its normal function. Specially designed insulating brackets are used for the mast in this case.

VARIABLE H.T. POWER PACK

By A. H. B. WALKER*
B.Sc. (Hons.), A.M.I.E.E.

Cathode-follower Rectifiers Giving Wide-range Voltage Control

ALTHOUGH stabilized h.t. power packs are widely used in electronic work, their stabilization ability is not always required and they are often used simply because they allow the h.t. voltage to be "turned up and down" in a most convenient way. This facility is useful, for example, in developing circuits which must in themselves be made independent of h.t. changes, as it enables the effects to be easily studied. Again, stabilized power packs often come to be used in laboratories because they form a convenient source of h.t. for a particular test, and the complication and expense of the stabilization system is frequently only justified for a small proportion of the time of use. Further, for various reasons such "luxury" power units do not normally provide the desirable facility of continuous control of the voltage from maximum down to substantially zero in one range. In practice, in experimental work it is very convenient to be able to turn on the h.t. supply gradually, as anyone who has had much experience of working with bench hook-ups will agree.

Drawbacks of Other Methods

A variable voltage h.t. supply can, of course, be obtained cheaply by using a potentiometer or a series resistor in conjunction with an existing power pack, but the series resistor method is undesirable as it produces very bad voltage regulation, and the potentiometer method is only satisfactory in this respect if the potentiometer current, and hence the power unit supplying it, is made very large in relation to the experimental load. Other methods are, of course, available (e.g., multi-ratio or variable transformers feeding the h.t. rectifier), but these involve additional equipment and offer no attractive features to offset the additional complication and expense, particularly in small light-weight power packs.

About two years ago the writer felt that, for these reasons, there was a need in his laboratory for a number of small non-stabilized h.t. and l.t. supply units which should be capable of delivering an output voltage continuously and smoothly adjustable from substantially zero up to the maximum, without introducing a higher output impedance than that of a normal fixed-voltage h.t. rectifier and smoothing filter. To conserve bench space the units were to be small and light and provided with self-contained voltmeter and milliammeter and with a low voltage supply for external valve heaters, while to justify themselves they had to be inexpensive. A simple design was evolved, and the power packs built to it have proved very satisfactory over two years' continuous laboratory use.

The circuit, which is perhaps a little unconventional, employs cathode-followers as the two rectifiers in a centre-tap rectifier circuit, but the action is more clearly followed if it is first considered in the simple diagrams of Fig. 1.

In the familiar circuit of Fig. 1(a), the cathode potential follows the d.c. potential applied to the grid, the anode current adjusting itself to the value necessary to develop the required voltage across the load resistor R. In Fig. 1(b) the steady d.c. grid potential is retained, but the anode supply has been changed to a.c. Assuming capacitor C to be disconnected, it is evident that the cathode potential will now follow the grid potential only during those portions of the positive half-cycle of the supply when the anode voltage is sufficiently high, and will fall to zero during intermediate periods. If a steady positive d.c. voltage of, say, 200 volts is applied to the grid, the waveform at the cathode will consist of a series of roughly flat-topped pulses 200 volts high. If the capacitor C is now connected across the load R, and the time constant CR is made sufficiently long, the cathode potential will tend to remain steady at a value somewhat

* Research Laboratory, Westinghouse Brake & Signal Co.

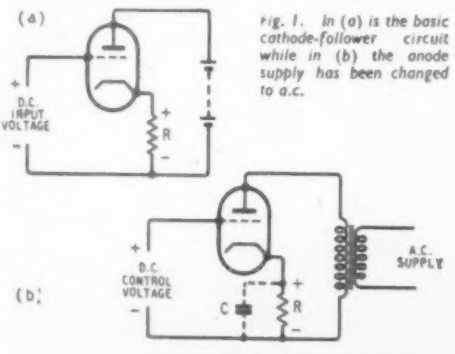


Fig. 1. In (a) is the basic cathode-follower circuit while in (b) the anode supply has been changed to a.c.

lower than the original peak potential, and both the peak value and the conduction angle of the anode current will increase as a result of a reduction in the net bias in order to sustain the increased power now being delivered to the load R. If the load current is now increased (R reduced) the output voltage will again fall slightly due to the anode resistance of the valve, but it will at all times remain under the control of the grid potential, and the additional power will be supplied by a lengthening of the valve conduction angle. Since the grid potential can be easily varied, this circuit provides a convenient way of setting the level of the d.c. voltage developed by the rectifier to any desired value with the minimum of components and complication. Clearly the best voltage regulation will be provided by a valve having a high slope and a low anode resistance, as in a normal d.c. operated cathode-follower circuit.

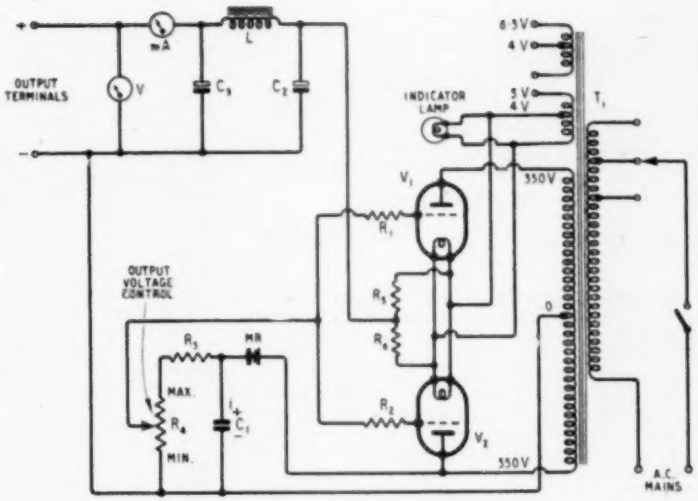


Fig. 2. Complete circuit diagram of the cathode-follower power pack.

The complete power pack circuit is shown in Fig. 2. It is basically that of Fig. 1(b), but a conventional centre-tap rectifier circuit has been used, followed by a normal smoothing filter. For reasons apparent from the above discussion, the smoothing filter cannot be of the choke input type, and a reservoir capacitor of moderate size is used in order to extend the conduction angle and reduce the peak valve current. The d.c. control voltage which is applied to the grids is obtained from one half of the centre-tapped transformer secondary winding by means of a miniature metal rectifier, a reservoir capacitor and a potentiometer (which forms the panel-mounted voltage control).

The Components

None of the components is in any way critical, and the power unit may be constructed almost completely of "surplus" parts if desired with a considerable saving in cost. The PX25 valves and the EP53 transformer were used as these were already available, although in order to reserve a free heater winding for external use (4 V and 6.3 V at 4 A), this meant that the other heater winding was necessarily loaded above its nominal rating. The transformer, however, appears to have an adequate safety margin, and no overheating results with the suggested layout. If a transformer having a centre-tapped winding for the rectifier filaments is available, or if indirectly heated valves are used, the artificial centre-tap potentiometer R_5R_6 will not of course be required. (In the original design a "humdinger" was used here, although there is, of course, no need for adjustment of the tapping point and two ½-watt resistors are simpler.) Other valves have not been tested in this circuit owing to the continued satisfactory performance of the PX25s, but any high-slope power triode or triode-connected tetrode or pentode should give very similar results.

LIST OF COMPONENTS

Resistors

R_1 and R_2	10kΩ, ½W
R_3 ..	100kΩ, ½W
R_4 ..	500kΩ potentiometer
R_5 and R_6	10Ω, ½W (or humdinger)

Capacitors

C_1 ..	4μF, 500V working. (Two 8μF, 350V working, T.C.C. type CE11L in series.)
C_2 and C_3	16μF, 450V working (T.C.C. type CE29P).

Choke

L ..	10H, 100mA (approx.)

Valves

V_1 and V_2	PX25 (or similar triodes or triode-connected tetrodes)

Metal Rectifier

MR ..	1,000V peak inverse, 1mA (Westinghouse 36K12)

Voltmeter

V ..	Miniature moving-coil, 500V f.s.d. (Ernest Turner model 225)

Milliammeter

mA ..	Miniature moving-coil, 100mA f.s.d. (Ernest Turner model 225)

Mains Transformer

T_1 ..	Primary: 200/250V Secondaries: 350-0-350V at 130mA 4V at 4A (see text) 4V and 6.3V at 4A (optional) (Varley type EP53)

Case .. Imhof type 1050 with handles type 10A (modified as in text)

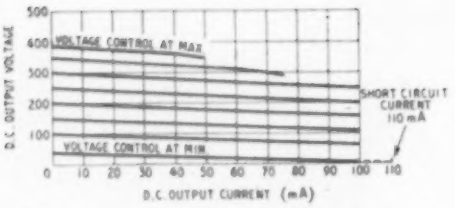


Fig. 3. Output regulation curves at different settings of the voltage control.

The output circuit is isolated from the chassis in order to allow the use of the power pack as a negative supply when necessary in experimental work, and similarly the auxiliary heater winding is left isolated and is brought out to terminals on the panel.

For convenience in use, and to save bench space, the components were assembled in a small commercially-made case measuring only 10in × 7in × 6in. The existing ventilation of such a small case was inadequate and so was increased by cutting two 1¼in diameter holes in the top and protecting these by an oval-shaped plate supported clear of the top by four small pillars. Two flat-topped "U" handles taller than the ventilator are fixed to the top of the case, and these form a convenient support for other equipment (or a further power unit) which may be stood on the top of the case without restricting the ventilation or becoming overheated. The ventilator also forms a conveniently shaped cleat round which the mains lead may be coiled for storage.

Details of Construction

Construction is simple, and the layout is non-critical except that there is not a great deal of space available, and if alternative components are used they should preferably not be much larger than those specified. If a different type of case is used it is important to see that adequate air-inlets are provided at the sides to cool the transformer and the electrolytic capacitors, since the heat to be dissipated is considerable. No fuses were included in the original models, but there is space for a fuseholder beneath the chassis if desired. Note that the cases of the electrolytic capacitors must be insulated from the chassis by strips of insulating cloth inside the mounting clips if it is desired to retain the flexibility of using the power unit as a negative supply.

Rear view of the power pack when taken out of its case.

Output voltage regulation curves with the control set to a number of different positions are shown in Fig. 3. The slope of these curves (which include the smoothing choke drop) corresponds to a d.c. output resistance of approximately 400 ohms, which is very similar to the output impedance of a conventional rectifier and smoothing filter. The performance of equipment fed from this variable voltage supply will therefore be similar to that which it would have when fed from a normal power unit.

In practical use, the small variations in voltage which result from mean load current changes are easily corrected by adjustment of the control knob, and the slight voltage regulation has not in practice proved troublesome. The attractive features of wide-range adjustable voltage, small size and weight and built-in metering have resulted in noticeable popularity of these power packs over the past two years in the writer's laboratory, and have enabled stabilized power units to be reserved for work which really requires very high stability or low output impedance supplies. This has justified their design and construction, and it is hoped that the suggestion will be of use to others engaged on electronic development work.

MANUFACTURERS' LITERATURE

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Heat-resisting Glass used in r.f. insulators; an informative booklet "Physical Properties of Phoenix Glass," giving electrical, mechanical and other properties, from The British Heat Resisting Glass Co., Ltd., Phœnix Works, Loxdale Street, Bilston, Staffs.

Oscilloscope Camera Drive Unit with nine-speed gear box described in a leaflet from A.C. Cossor, Ltd., Cossor House, Highbury Grove, London, N.5.

Electronic Instruments for Nuclear Physics; a catalogue of equipment from Labgear (Cambridge), Ltd., Willow Place, Cambridge.

Valves for Industry and Communications; a revised and enlarged edition of a previous booklet, giving abridged data and general operational recommendations, from Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. Also a similar booklet on **Industrial Photocells**.

Signal Lamps; a supplement to their Catalogue No. 126 from Arcolectric Switches, Ltd., Central Avenue, West Molesey, Surrey, England.

Front-projection Television Receiver; a descriptive leaflet and servicing information from the Rainbow Radio Manufacturing Co., Ltd., Mincing Lane, Blackburn, Lancs.

Television Waveform Generators for 405-line, 525-line and 625-line systems described generally in a leaflet from Telequipment Electronic Instruments, 73a, Beresford Road, London, N.8.

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Mains Switches and other electrical accessories listed in a catalogue from J. A. Crabtree and Co., Ltd., Lincoln Works, Walsall, Staffs.

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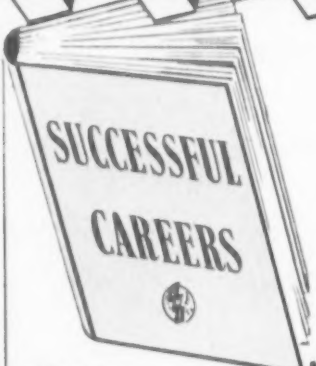

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IC 108

Reliable Valves and the User

How Circuit Designers and Operators Can Help the Manufacturer

By E. G. ROWE,* M.Sc., A.C.G.I., D.I.C.

WHILE valve engineers can design a reliable valve entirely by calculation and special testing, the achievement of satisfactory performance is not a matter of engineering design only, for the valve must be mass produced and then be capable of operating under a variety of conditions. As a result there are two other factors apart from design which affect the performance: control of manufacturing limits (which, of course, is the responsibility of the maker), and the attitude of the user towards the application of reliable valves. It is the second one with which we are now concerned.

An examination of the distribution of electrical characteristics of any valve in production shows that it is always wider for the first period of production, and the effect shows up even when well-established existing designs are reintroduced. Also, it has been proved that high valve reliability can be secured only if there is a high yield on manufacture (known as a low production "shrinkage"). Such a state is achieved by uninterrupted production over a considerable period of time, when the familiarity of the individual operator with the job secures maximum skill and consistency. Consequently, the philosophy of making reliable valves is that it is essential to keep the number of individual types to an absolute minimum and the quantity of each of these types as large as possible, so that long and continuous manufacturing runs can be carried out (see graph). An appeal must therefore be made to the circuit designer to do his best to confine himself to a short list of types, and to be prepared to use more valves of these types, if necessary, rather than use yet another type that may be more elegant technically.

When reliable valves have been used for reasonable periods in equipments, the valve maker will want to know how well the product is behaving in all of the special applications for which it has been designed and manufactured. No matter what the difficulties, this information must be obtained so that an accurate correlation can be maintained between field conditions and the many valve-testing machines used in the factory. It is appreciated that with equipments distributed all over the world, often in the hands of semi-trained operators, this requirement is not easy to meet, but it has been solved by the air lines in both Canada and the U.S.A., and determined attempts are now being made in this country to see that the valve manufacturer is not hamstrung for lack of information.

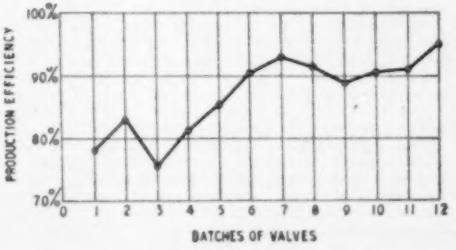
This policy of user-manufacturer liaison has benefits for the user as well. Each batch of valves that is manufactured is carefully tested for the main mechanical and electrical requirements, and samples of the valves are always exhaustively checked to the point of destruction for certain of the special characteristics. While this is going on careful records are kept of the performance, and these are retained so that individual valves may be traced and their performance assessed. Criticisms or complaints from users can then be investigated with a very real probability of satisfaction for both parties.

Perhaps the most important thing of all is the user's attitude towards the application of reliable valves. Past experience in the commercial manufacture of valves has shown over and over again that conservative operation leads to longer life and less frequent catastrophic failure from such causes as low emission or gas. This is especially true of unusual applications where the valve is often required to do a job for which it is unsuited by reason of design or method of manufacture. It would be illogical to assume that the reliable valve will be better in this respect simply because it is designed to give less trouble under severe mechanical conditions. It cannot be emphasized too strongly that the valve is a willing little chap too ready to give his life in the service of his master—and is very often required to do so!

Whilst the main effort of both valve maker and user is directed at present towards the immediate problem of making existing equipments more reliable by using valves that are replacements of existing types, it is very important that the policy for the future is well defined.

The biggest stumbling block to the ultimate reliability of glass-based valves is the valve holder. The valve manufacturer has recognized the problems of incompatibility between valves and valve holders and has compromised by specifying the use of a wiring jig to centralize the socket contacts during circuit assembly and a pin-straightening jig for the valve pins

Graph showing the increase in production efficiency with the number of batches of valves made in continuous manufacture.



* Brimar Valve Division, Standard Telephones and Cables Ltd.

before insertion into the valve holder. Despite all this, considerable evidence has been obtained that semi-skilled personnel can cause a "mechanical insertion" loss of 3 per cent or greater, and whilst this can be reduced by careful training, the requirement of 1 per cent failure in 1,000 hours (agreed as an objective definition of reliability) is easily swamped by this single possibility.

Because of the inevitability of some loss due to this, it is clear that for requirements demanding absolute reliability the valves will have flying leads and will be soldered into the circuit. The size of the envelope will be dependent on the dissipation requirement, the sub-miniature being used for low-dissipation valves with the miniature and noval types for better characteristics and higher dissipations.

Results of the present programme of work on reliable valves are likely to show that the valve is no longer the prime limiting factor to trouble-free performance of electronic equipment, and it is anticipated that the user will be turning to manufacturers of other circuit components for assurance of equal standards of reliability. This situation is already occurring with miniature potted circuits—the self-contained units including sub-miniature valves and components designed for ease of mass production and assembly.

In conclusion, it must be acknowledged that the user's attitude has up to the present been of real assistance in the design and early manufacture of the reliable valve. Considerable evidence has already been obtained from the Armed Services regarding the applications of the valves, and it is hoped that this trend will be continued when industrial equipment manufacturers begin to use them in quantity.

BOOK REVIEW

Amplifiers: The Why and How of Good Amplification, by G. A. Briggs and H. H. Garner, Pp. 202 + XIII and 178 illustrations. Wharfedale Wireless Works, Bradford Road, Idle, Bradford. Price 15s 6d.

ONE criticism that cannot be levelled at this book is that the authors have been parsimonious in the amount of material presented. In this respect, and in the method of presentation, "Amplifiers" follows the precedents of the previous "Loudspeakers" and "Sound Reproduction," between which it forms a link.

Having, with the skill of Autolycus, collected a bumper harvest—not excluding some notes on the care and maintenance of electrical machinery—the authors have sat down to sift and bag the crop, and here one feels their touch has been less deft. We all know that the best way to learn about a subject is to write about it, but having by devious paths arrived within grasp of the truth, it is not a bad plan to tear up the first draft and start again. Too often the authors have left in their rough working for all to see, and, as this is sometimes self-contradicting, it must be difficult for the beginner, for whom this book was written, to know where he is.

For instance, we are told (p. 54) that the function of a grid stopper resistance is to introduce damping into any fortuitous oscillatory circuits associated with the valve and that this resistance "will not reduce the input voltage to the grid." Five lines further on we find that the grid stopper in conjunction with the grid-cathode capacitance forms a low-pass filter and attenuates the high frequencies.

Other topics which the authors seem to have found rather indigestible include the rôle of transformers in coupling loads to valves, and the reasons why the optimum load for maximum power output is sometimes equal to and sometimes twice the valve a.c. resistance. The significance of the valve cathode as an equipotential surface is not sufficiently stressed, and hum in directly-heated filaments is ascribed (p. 21) to lack of thermal capacity. The virtues of barretters as mains voltage dropping resistances are rightly attributed (p. 56) to the fact that the resistance of the filament increases with temperature, but on the previous page "bargain" type wire-wound resistors with a high temperature coefficient are condemned. But the dyspeptic biscuit should be reserved for the treatment of loudspeaker damping, pp. 45-47, where it is stated that the coil when falling to rest will generate an e.m.f. "which will cause a current to flow in the coil and the field produced will interact with the flux of the field and tend to cause a movement in the opposite direction to the original one, taking the system past its dead centre position instead of coming to rest immediately." While this may not secure for the authors a patent for perpetual motion, it might form the basis of a new magnetic gun!

One final quotation in support of what must be the main criticism of this book: that the "Why" is less to be relied upon than the "How." On p. 172 in the chapter on hum we are told "The chassis can influence the spread of electro-magnetic hum. Magnetic materials are commonly employed and strong eddy currents exist throughout such substances. These can be virtually eliminated by using a dia-magnetic material such as aluminium, duralumin, or best of all copper which is even silver-plated in the highest grades of professional apparatus." We will overlook the error of including aluminium among diamagnetic materials, and, following the Euclidean technique, pursue the authors' thought to its logical conclusion, which is that we may well soon be asked to consider the virtues of yet higher grades of apparatus in which the copper chassis are coated with bismuth (seven times more diamagnetic than silver). Home constructors will no doubt content themselves by wiping their chassis over with a paraffiny rag (diamagnetism $\times 3$ Ag). It may smell, but it will deter eddy currents, for as well as being diamagnetic it is an insulator, and cases have been brought to our notice in which eddy currents have been known to flow even in diamagnetic conductors!

The authors' belief that touches of humour enliven the text of technical books is commendable (and it is to be hoped they do not deny book critics a similar licence), but to be effective the jokes must flower in the right place and ungerminated seeds of humour must not be left lurking in seriously-intended passages.

If the Factual is not carefully sifted and becomes merely the Memorable, there is a risk that some readers, starting with the knowledge that the book will at times be intentionally funny, may think that the authors are trying to do for Good Amplification what Sellar and Yeatman once did for History.

F. L. D.

RESISTOR COLOUR CODES

AFTER being in almost general use for some time, the well-known colour coding of resistance values has now reached the status of a British Standard and is the subject of a new specification, B.S. 1852:1952. It defines the colours to be used, their significance and the methods of marking. Both coloured bands and the coloured body, tip and spot (or band) systems are approved, but the bands located at one end is the preferred arrangement.

A maximum of five bands is approved, the first three giving the resistance value, the fourth the percentage tolerance and the fifth the grade. In the alternative form of marking (coloured body, tip and spot) the tolerance is indicated by the appropriate colouring of the second tip of the resistor. Thus both ends may have colours differing from the body

As the colours and corresponding numerical values are the same as those in general use now, they will not be repeated here. The coding is defined as applying to fixed resistors for telecommunication purposes.

Copies of the specification are obtainable from British Standards Institution, 24, Victoria Street, London, S.W.1, and cost 1s, including postage.

Bankers' Television

Remote Inspection of Documents

MOST banks manage to keep a watchful eye on their customers' overdrafts without a great deal of trouble, but the London firm of private bankers, Glyn Mills and Company, are somewhat unconventional in this respect—they do it by television. The reason is that one of their branches is divided into two, the main office being in Whitehall while the pay and ledger departments are at Osterley Park, some ten miles away. When this arrangement became necessary a few years ago it naturally created quite a problem in communications, particularly when staff in Whitehall had to get detailed information from documents kept at Osterley. It was clear that telephoning or teleprinting would be too slow and would introduce the possibility of human error—and, of course, they would be no use for verifying signatures on cheques. Phototelegraphy would be better, but still too slow. Obviously the only real answer to the problem was television, so in due course an experimental one-way television system was installed, using a radio channel for transmission of pictures from Osterley to Whitehall. Whether it will now become permanent or not depends partly on the question of cost and partly on the willingness of the Post Office to grant a permanent licence for the stations.

On Decimetre Waves

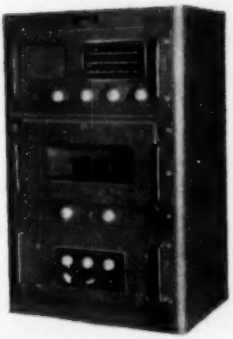
The equipment has been provided by Pye Ltd. of Cambridge. It consists of a small camera and control unit at Osterley, a 15-cm radio link beaming about half a watt of r.f. energy between paraboloidal aerials, and a small-screen desk receiver at Whitehall. There is also a remote control system which enables the viewer in Whitehall to move the camera about so that he can look at any particular part of a document. This works by sending different levels of two a.f. tones over a telephone line, which is also used for verbal communication. The picture obtained is very clear and is generally arranged to be larger than life size.

Miniature Camera

While television may seem a rather expensive luxury for private organizations to indulge in (the estimated cost of the installation is £10,000), the camera and its associated gear at Osterley actually come from a small transportable "industrial television" outfit which Pye have designed especially with an eye to simplicity and low cost. The miniature "Staticon" camera, which has a three-lens turret, measures only 11in × 6½in × 4½in, and weighs under 13lb, and apart from the tiny pick-up tube (length 7in, diameter 1in), with its focus and deflector coils, it contains no more than a video amplifier and a tube blanking amplifier. Everything else—waveform generators, controls, power supplies, and so on—is housed in a separate unit, which also contains a 9-in cathode ray tube for monitoring. The definition used for the Glyn Mills television link is 525 lines, but the equipment can also be arranged to work on 405 and 625 lines.

As an interesting sidelight on the economics of the system, Glyn Mills and Company point out that the use of television in this way could actually reduce the overhead costs of city offices by making it possible for bulky records to be kept in the suburbs, where the rents and rates for office accommodation are very much lower. Moreover, the staffs of the suburban offices could live nearby and so save on travelling expenses.

(Above) Pictures are viewed at the main office in Whitehall on this small desk receiver. (Right) The miniature "Staticon" camera and its mounting at the transmitting end.



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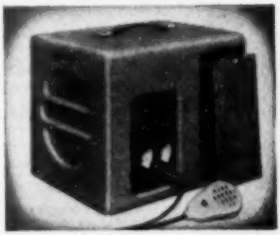

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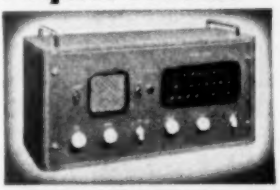

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RANDOM RADIATIONS

By "DIALLIST"

Franco-British Television

AS A TECHNICAL ACHIEVEMENT, the relaying of French 819-line television by the British 405-line network was an undoubted success. It showed beyond a doubt that, thunderstorms apart, the conversion of one 50-frame scanning standard to another and the relaying of television transmissions over great distances are things which can now be done at will. Apart from their novelty, the entertainment value of the programmes that I saw was not very great; but there is every reason for expecting rapid improvements here. The definition was, on the whole, surprisingly good—I was particularly struck by its excellence in the military tournament relay.

T'other Way Round

Actually two separate and distinct conversions were made during these transmissions. The French engineers had rigged up a convertor on the lines of that developed by the B.B.C. and by means of this they successfully relayed the 819-line transmission over their 441-line system. Notice, though, that in both instances the conversion was from a larger number of scanning lines to a smaller. It remains to be seen what will happen when we relay our programmes to France and they are converted t'other way round from 405 to 441 and 819 lines. The 405-line image will, of course, be spot-wobbled to remove all lininess, and I feel pretty sure that French viewers with 819-line receivers will be agreeably surprised by the high quality of the images on their screens.

The Viewer's Bugbear

TUCKED AWAY amongst a dozen paragraphs in "World of Wireless" on page 225 of the June, 1951 issue, was one which stated that regular test transmissions of 819-line television were being made from a transmitter in the Eiffel Tower with a pass-band of only 4 Mc/s. To balance vertical and horizontal definition with an 819-line, 50-frames-a-second scan the modulation bandwidth required is about 14 Mc/s: the horizontal definition of a transmission made with a 4 Mc/s pass-band must be extraordinarily poor. Yet, *La Télévision Française* predicted at the time that it would prove acceptable to viewers so long as there was good contrast and good vertical definition, unbroken by line structure. Ever since that paragraph appeared, more than a year ago, I have kept a watch on French technical and lay publications for any adverse criticism of the quality of those transmissions. Not one word have I seen of any such comment. And that goes to prove the truth of the contention that I have so often advanced: *the* most offensive quality to the average viewer in a television image is lininess. You can prove to him by higher, lower or medium mathematics that what he really wants is balanced definition. "I'm sure you're right, old boy," he says; "but what I can't stick is those lines across the picture." Eliminate the lininess, as can so easily be done by means of spot-wobble or some equivalent trick, and your average viewer will begin to appreciate the value of balance in definition. But leave the image liny and he'll go on clamouring for what he misguidedly calls higher definition in the shape of more scanning lines—quite irrespective of the pass-band of either transmitter or receiver. Myself, I'm firmly convinced that the real answer to the viewer's prayer is either spot-wobble or spot-elongation.

Hard Labour

ONE OF MY RECEIVERS recently became intermittently noisy, although there was clearly nothing wrong with the receiver itself, for when taken into another room it behaved perfectly—even when its cabinet was shaken or rapped with the knuckles. But, in its own particular corner it emitted every now and then a volley of crackles and bangs, accompanied by variations in the volume of sound from the loudspeaker. It could be made, I found eventually, to do these things if one walked across one part of the floor. As there were two skirting-board 5-amp sockets in the neighbourhood, I knew that there must be a junction box below the largish area of floor-boards, the crossing of which produced a devastating response from the set. Despite the prevailing heat-wave, the furniture was shifted, the carpet rolled back and the necessary tools were collected.

Electricians, Please Note

Well, it shouldn't be hard to locate that junction box and to deal with the loose contact which it obviously contained. There would certainly be, immediately above it, a short piece of floor-board, between two adjacent joists. I found nothing of the kind. Every plank was from 8 to 15 feet in length. Carefully observed results of deliberately heavy tramping over the bare boards pointed to one 8ft plank as the probable concealer of the defective junction box. They

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were sound, thick boards and they were well and truly nailed down. When, after some hard work with hammer and the tool known as an "electrician's chisel," I had raised that plank, I found beneath it nothing more than an innocent lead-covered cable. After an interval for cooling off, I made careful measurements and decided that the box must be under a certain 12ft board. Having got that one up, I found I could see the box—but it was out of reach, for it was covered by the next floor-board but one—also a 12-footer. Further interval for cooling off; then at last up came the right plank. Sure enough, one of the connections in the junction box had become loose. This was put right in a jiffy. In fact, the job which actually took the best (or worst!) part of three perspiring hours, could have been done in ten minutes if only some thoughtless electrician had had the sense to saw through the floor-board and to leave an obvious short length above the box. Will electricians please note? My own practice—which may be a counsel of perfection—when rewiring, is to mark the short plank with a carpenter's pencil: "Junction box 5A," or "Junction box 15A," and to leave under it or on the joist a sheet of paper showing the connections of the various leads.

Gas Fitters, Too

THERE APPEARS to be a lamentable gap in the training of the skilled men who come, at our behest, to install gas connections in our homes. From conversations with not a few of them I gather that their training includes no instruction about the lighting and power cables that they are likely to encounter in the average house and that they are told nothing about the I.E.E.'s eminently sound regulation that the lead sheathing or the steel conduits of cables must not come into contact with gas pipes. A particular point in a gas pipe may be pretty well insulated from earth and, therefore, there may be a considerable potential difference between it and a properly earthed lead sheathing or conduit. Quite apart from the danger if an escape of gas occurs, intermittent contact between sheathing or conduit and a dirty gas pipe can lead to noisiness in the radio set. The electrically uninstructed gas man may (and too often does, if you're not there to keep an eye on him) nullify all the precautions you take to make your electric wiring safe and unproductive of noise in the wireless set.

See us at the
RADIO SHOW*
Bulgin Radio and Electronic components have, since the inception of broadcasting, gained and held a world-wide reputation, second to none, for quality and reliability.
Continuous attention to detail is one of the first considerations throughout the design and manufacture of these components; only first-grade materials and workmanship are used in their manufacture, backed by works and laboratory staffs of fully qualified trained and specialist engineers who maintain a constant vigil over new developments in radio and electronic technique, thus ensuring that Bulgin components embody all possible up-to-the-minute features.
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BYE-PASS ROAD BARKING

UNBIASED

By FREE GRID

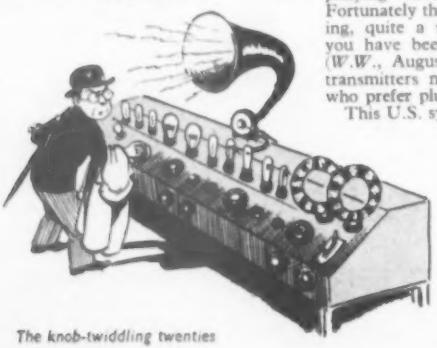
Comparisons are Odious

IN the far-off days of the knob-twiddling twenties, when each of our valves had a variable filament control and every circuit had its individual tuning knob, we pioneers were content with very simple Anglo-Saxon names for the bricks and mortar with which we built our sets. We talked vulgarly of condensers instead of capacitors; as for the variable ones, our unit of capacity, or capacitance, as I should say, was not the microfarad but the "plate," just as our unit of inductance was the "turn" and not the microhenry. We were content also to speak of the filament, grid and plate of our simple valves although some of us who thought we were more learned than others talked arrogantly of "anodes."

All this has, of course, long since changed and our vocabulary of technical terms has been ruthlessly hellenicized. But here and there we come across reminders of the vulgar Anglo-Saxon past, such as in the continuous use of the expression "magic-eye" instead of "cathode-ray tuning indicator" or "thermionic indicator." Perhaps, however, this is not a very fitting example as it has never been used in the innermost circles of radio engineering but, like the name magic lantern, only survives among women and technically ignorant but financially important people to whom set manufacturers must perforce pander if they are to keep out of Carey Street.

A far better instance of what I am getting at is provided by the word "grid" which, despite all the technical terminological changes that have taken place, still preserves its original name given because it looked like a grid just as the "plate" was so called because in its pre-cylindrical days, at any rate, it looked like one. Comparisons are always odious, but they are so in more senses than one in this particular case, where the various grids of the valve preserve their plebeian names while the two original workers in the thermionic vineyard have long ago joined the patrician "ode" family which flourished long before the day when Fleming first pressed cathode rays into the service of "wireless" (16.11.'04).

There would be no difficulty in finding suitable names equal in euphony, dignity and functional description as the cathode and anode. The control grid, for instance, could obviously become an "archode" and all the auxiliary grids could have names of equal aptitude; and while we are about it we mustn't forget the humble heater which would sound so much more imposing as a "thermode."



The knob-twiddling twenties

The Telesmellies

ALTHOUGH the threat to the B.B.C.'s monopoly of sponsored television is at present "like a cloud no bigger than a man's hand," if I may follow the popular example in misquoting the words of Elijah's servant, we may find that the broadcasting heavens may eventually be black with clouds. If that happens it will be of little use girding up our loins and running like Elijah for there won't be anywhere to run to in order to get out of the storm. Sponsored television would only be the precursor of "sponsored-everything-else."

We can, of course, to some extent defend ourselves from this new menace by forcing the Government to introduce a bill to compel any sponsoring company to which it granted a licence to fit all its transmitters with the necessary apparatus so that listeners who want to hear the programmes without the accompanying advertising could do so. Fortunately this is, technically speaking, quite a simple matter and, as you have been quite correctly told (*W.W.*, August, 1951), certain U.S. transmitters now cater for listeners who prefer plug-free programmes.

This U.S. system of vocal evisceration or cackle-cutting ought to be adopted here. It would first be necessary to provide everybody with a special television receiver or adaptor unit at the expense of the sponsoring company which would give a tremendous fillip to the business of all sections of the radio industry. These receivers would be fitted with a blurb-bludgeoning relay which would be actuated by special signals sent out from the transmitter whenever the sponsorer's tall-tale teller came on the air to talk about the goods or services provided by his company. Should some viewers with perverted American tastes really want to hear all about "Buggins' Bed-bug Banisher" a turn of a switch would cut out the relay.

There is nothing in the least fanciful about this and I would suggest that the system be extended and the B.B.C. be compelled to send out these special cackle-cutting signals so that we can muffle the mouthings with which certain of the disc jockeys mar the music they provide for us.

This system of causing the transmitter to operate relays in the receiver has its dangers, of course, since the advertising moguls might easily fit the receivers with bottled perfumes and a relay-operated release valve on each cylinder. The addition of the smell of fragrant coffee and crisp gammon rashers to a televised breakfast scene would undoubtedly lower the sales resistance of viewers to these comestibles, and the realistic effect of a whiff of sulphuretted hydrogen added to a documentary on drains would have to be smelt to be believed. The result of this would be that the commercial broadcasting interests would unjustly get the credit of having invented the telesmellies.

Realistic effect

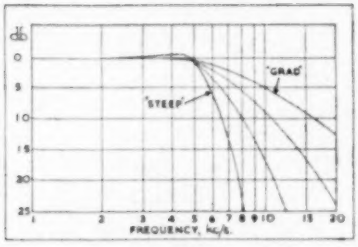
History Repeats Itself

IT did not surprise me to read that a County Medical Officer had drawn attention to the bad effect on children's health produced by long hours in a stuffy room gazing at television. I well recollect hearing from my mother of the stern denunciation by her father of similar evil effects produced by over-addiction to the musical box and zoetrope. In my young days the phonograph and the bioscope were the scapegoats, while, of course, tickling cats' whiskers brought my own children to the verge of physical and moral ruin. Interplanetary travel during homework hours will, I feel sure, undermine the health of my great-grandchildren.

A RADICALLY NEW PRE-AMPLIFIER FOR LEAK 'POINT-ONE' POWER AMPLIFIERS

The

"Vari-Slope"



Frequency/amplitude curves for the "TREBLE—3" position (5 kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7 kc/s and 9 kc/s ("—2" and "—1" positions).

The filters consist essentially of twin-T resistor-capacitor networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include :—

(a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."

(b) Extremely low harmonic and intermodulation distortion due to negative voltage feedback action.

(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control altering the terminating impedance and the insertion loss.)

(d) There are no chokes to cause magnetic hum pick-up.

(e) Smaller size, lighter weight, greater uniformity in production.

AUDIBLY BETTER REPRODUCTION

from unique

FEEDBACK CIRCUIT DEVELOPMENT

The new "Vari-Slope" pre-amplifier has a refinement which will doubtless set the pattern for future high-fidelity reproducing amplifiers. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles.

No Inductors ("Chokes") are used, and all their disadvantages are completely eliminated. The turnover frequencies are 5kc/s, 7kc/s, and 9kc/s and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.

PRICE **£12-12-0** LIST
IN BRITAIN

TO BRITISH USERS OF THE
RC/PA/U PRE-AMPLIFIER

Your old model can be rebuilt as a standard "VARI-SLOPE" at a charge of £8.8.0.

Orders will be booked in rotation.

Please do not send your pre-amplifier to us until we advise you of a date.

OVERSEAS USERS should contact their national agent regarding the availability of this rebuilding service, which is dependent on freight and reimport duties being reasonably low.

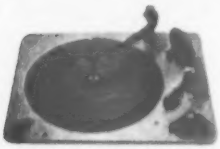
Write for "Vari-Slope" Leaflet

H. J. LEAK & CO., LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3.

Phone : SHEpherds Bush 1173/4. Telegrams : Sinusoidal, Ealux, London. Cables : Sinusoidal, London.

ELPREQ PAGES

Send 4/6 for latest Crystal valve, we will include free blueprint showing how to construct efficient crystal radio which needs no batteries. One valve blueprint 1/6.



THREE AUTO CHANGER BARGAINS

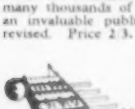
Garrard RC72 3-speed with dual-purpose head, **15 gns.**
Collaro RC511 3-speed with dual-purpose head, **11 gns.**
Garrard R70B single-speed with crystal head, **10 gns.**
Carriage and packing 7/6 extra.

T.V. CABINET

This is a very handsome walnut finished cabinet ideal for View-master or practically any other T.V. using up to a 12in. tube. A platform is fitted but it is a small matter to alter the position to suit your own chassis. Baffle board for 10in. loudspeaker is also included as is a hardboard back. Internal dimensions 2ft. 7in. high × 1ft. 4in. wide × 1ft. 8in. deep. Price **£9 9/-** carriage and packing 10/- extra.

DEMOBBED VALVES

Gives the commercial equivalents of many thousands of Service valves, an invaluable publication recently revised. Price **2/3.**

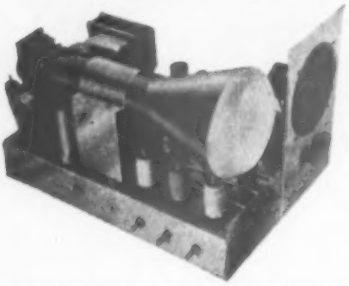


PUSH BUTTON SWITCHES

Nine push type, **3/6.** Four push type, one operates mains on/off switch, **2/9.** Three push type, **2/3.** Knobs **1d.** each extra.

THE 'ARGUS' TELEVISION RECEIVER

A 21 Valve 6in. C.R. Tube Unit-built Televisor for the Amateur



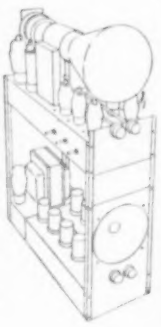
Although this televisor costs only about £20, it does not involve the conversion of ex-Government units, and has been designed for construction by the novice. The circuits have been kept straightforward and devoid of "frills," though nothing has been sacrificed which would assist in its efficient and stable operation.

The cathode-ray tube used is a VCR97. This 6in. tube was chosen as it is readily available at a low cost, and is capable of providing pictures of very good quality. The trace is green, but one soon becomes accustomed to the colour, and it is very restful to the eyes.

The chassis is divided into five separate units, which makes for ease of construction; the units are vision receiver; sound receiver; time base; E.H.T. Supply and C.R.T. network; and power unit. Each unit is complete on its own chassis, and when finished all units are bolted together to form the complete televisor.

We can supply all the parts for **£20 10/-**, H.P. terms are available, deposit being **£7**, balance 12 monthly payments of **£1 6/-** each. Carriage and packing 10/- extra.

A reprint of the data which originally appeared in "Practical Television," together with some additional diagrams and notes produced by our Television engineers are available as a constructor's Envelope. Price 5/- post free.



THE ARGUS ARRANGED AS A CONSOLE →

MAGNETIC TAPE RECORDER YOURS FOR £9 15 0

CABINETS AVAILABLE SEPARATELY £4 17 6

Tape Deck. Fitted with 3 motors giving fast rewind forward run and no friction. High fidelity record playback giving approximately 1 hour playing from standard 1,200ft. tape. Tape, 35/- per reel.

Amplifier. High gain enables recording to be made from microphone, pick-up, or loudspeaker. Separate bass and treble lift controls.

Cabinet. Portable, is rexine covered, table model is polished walnut.

Instruction Booklet. Shows in close detail exactly how to assemble and operate the recorder, is free with kit or available separately at 5/- (credited if you buy kit or complete recorder).

Price. Complete kit of parts including 6 B.V.A. valves, loudspeaker and cabinet (state whether portable or table model required), **£29 5/-**, or **£9 15/-** deposit and balance over 12 months. If required we will assemble and test for **£4** extra. Suitable crystal hand/table microphone, **£1 15/-** extra.

HIGH WATTAGE AUTO TRANSFORMERS

Input tapped for 200-240 v. Output 115 v. Loading: 1 kVA. (1,000 watts), **£6 10/-** carr. 5/-; 1.5 kVA. (1,500 watts) **£7 17 6**, carr. 5/-; 2 kVA. (2,000 watts) **£10 17 6**, carr. 7/6; 3 kVA. (3,000 watts) **£12 7 6**, carr. 10/-.

CONTINUOUSLY VARIABLE MAINS TRANSFORMER

As described in the August 1951 issue, this has a primary tapped at 81 v. and four secondaries of 1 v., 3 v., 9 v. and 27 v. respectively. By suitable selection of windings, voltage in steps of 1 v. up to 40 v. can be obtained with isolation from the mains at 100-watt rating, e.g., 20 amps. at 5 v. and 2½ amps. at 40 v. By adding the primary the voltage can be varied in steps of 1 v. up to 280 v.

This is undoubtedly an essential piece of equipment in all experimental laboratories. Price **£3 10/-** each.

WELDING TRANSFORMERS

12 v. 50 amp. output from 200-240 v. A.C. mains.

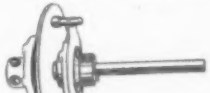
Primary and secondary separated by a special screen to prevent interference, this screen is brought out to the terminal block. Complete in metal case with carrying handle, price **£4 5/-**, plus 5/- carriage and packing.

PYREX AERIAL INSULATORS

Ideal for aerial connections through cabin walls or through panels. Consists of glass dome with threaded rod and terminal ends and metal fixing flange. Price 2/- each.

EPICYCLIC DRIVES

Double drive with wheel for driving pointer, 8.1 ratio. Price **3/9.** Single drive. Price **2/9.**



BRASS CASED PLUG

Seven-way brass cased plug, ideal for portable apparatus. Price 2/3 each half. D33BR and D33BL.

LATE ARRIVALS

WESTINGHOUSE METER RECTIFIER

Type M3, suitable for meter using up to 50 mA. Price 3/6 each.

MUIRHEAD SLOW MOTION DRIVE

Vernier Drive type D, with scale/lamp attachment service reference 10E/8510. Price 10/6.

POT. METER

Wire wound on ceramic former, 500 ohms 20-watt rating. Service reference 10W/10548. Price 5/6.

WAVE-CHANGE SWITCHES

Of course we stock all popular sizes and types, but special this month is a midget type with long spindle, ideal for coil pack, etc. Price 2/11.

COMPRESSOR/VAC PUMP

Fitted with outlet and inlet valve, suitable for paint spraying, refrigerator, etc., complete with V belt drive wheel. Price £3/15/-.

AIR BOTTLE

Fitted with inlet and outlet valves, tested to stand very high pressure. Price 37/6 each.

THIS MONTH'S SNIP

Multi-Ratio Output Transformer by very famous maker. Normal price 10/6. Our price, 4/6; 48/- per dozen.

MAGNETRONS—KLYSTRONS—TRIGGERTRONS, ETC.

We specialise in the supply of ordinary Receiving types, Mullard, Brimar Cossor, Osram, Marconi, etc., and have always carried very large stocks, consequently we still supply most types from our single Tax stocks, which for you means the saving of 2- to 3- per valve. We operate a prompt insured C.O.D. service on these valves and will be happy to execute your orders.

We have never specialised in Transmitting and industrial types, but naturally we have acquired quite a quantity of these in our bulk purchases over the years. On sorting them through we find many interesting and special-purpose types, and being mostly war surplus, we can offer all at a considerable reduction on cost prices. For your further information also we can usually get any type of valve, so if you do not see your special requirement listed here, please send us an enquiry.

AMERICAN MAGNETRON

2B26	805	8011
2C34	807	DET12
4C27	813	DET19
6C4	830B	RK20A
3D6	832	RK28A
6J6	860	RKR72
12AT7	866	RL5
35T	866A	RL7
54 Gammatron	923	RL18
259A	954	RX235
714AB	1616	TZ0520
717A	1625	VT90
723AB	1629	VT114
801	4064B	VTX3
803	4074B	WE3A
	4328A	

CV2654

CV210

CV12	CV187	CV1051	CV1137
CV13	CV188	CV1053	CV1139
CV18	CV193	CV1054	CV1141
CV19	CV210	CV1055	CV1147
CV20	CV271	CV1056	CV1152
CV22	CV321	CV1057	CV1170
CV31	CV327	CV1060	CV1175
CV32	CV534	CV1061	CV1187
CV37	CV594	CV1061A	CV1191
CV43	CV619	CV1062	CV1197
CV45	CV621	CV1065	CV1199
CV51	CV634	CV1066	CV1284
CV53	CV640	CV1074	CV1300
CV54	CV656	CV1075	CV1306
CV57	CV659	CV1078	CV1310
CV63	CV665	CV1090	CV1311
CV65	CV668	CV1091	CV1366
CV67	CV686	CV1092	CV1367
CV72	CV702	CV1094	CV1368
CV72	CV704	CV1095	CV1449
CV73	CV755	CV1101	CV1481
CV74	CV773	CV1102	CV1504
CV82	CV779	CV1104	CV1508
CV85	CV781	CV1105	CV1573
CV92	CV849	CV1106	CV1653
CV93	CV852	CV1107	CV1755
CV115	CV895	CV1108	CV1913
CV117	CV922	CV1110	CV1943
CV118	CV1000	CV1111	CV2539
CV120	CV1018	CV1118	CV2579
CV129	CV1020	CV1120	CV2679
CV133	CV1023	CV1124	CV2710
CV138	CV1025	CV1125	CV2941
CV147	CV1029	CV1126	CV2945
CV148	CV1031	CV1127	CV3581
CV158	CV1032	CV1128	CV3793
CV160	CV1033	CV1129	
CV177	CV1035	CV1133	
CV185	CV1037	CV1135	
	CV1047	CV1136	

CV1090

CV1114

CV2579

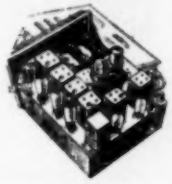
GOVERMENT SURPLUS EQUIPMENT

RDF1

Ex-Army unit contains 13 valves as follows: 5 of SP61, 2 of P61, 3 of EA50, and CV63, ER34, EC52. In an article entitled the "£9 Televisor," published in "Practical Television," details are given showing how to make a Televisor using this unit. A reprint of this article is given free to all purchasers. Price 49/6, carriage and packing 5/-.

10-VALVE 1¼-METRE SUPERHET

Ideal for conversion into a Televisor. These contain 6 valves type SP61, and one each RL7, RL16, and EA50. Six IF transformers of 12 Mc/s band width, and hundreds of other useful components. Price 59/6, plus carriage and packing 7/6. These receivers are unused and in original wrappings.



RF UNIT TYPE 24

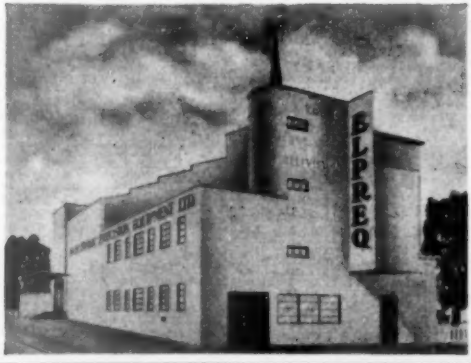
Contains 3 valves, SP61 and miscellaneous HF components ideal for conversion for all TV frequencies. Supplied complete with conversion data. Price 25/-.

FULL PICTURE VCR97

We have had a new delivery of this now-famous electrostatic 6in. T.V. tube, these are not the cut-off type, and we guarantee a full picture, 42/6, carriage and insurance, 5/-.

RECEIVER R1124

This receiver contains a host of useful stuff, the most important of which is a coil pack which needs only the adjustment of its trimmers to receive A.P. sound. The valves contained are three type 9D2 and one each of 8D2, 4D1 and 15D2. We understand that these receivers have never been used. Price only 18/6 each, plus 2/6 postage.



The building you see alongside is our new Mail Order Depot at Harrow. We have not been able to move in yet however due to delays over licences, etc. Therefore until further notice, please continue to address Post Orders to E.P.E. Ltd. (Dept. 2), Windmill Hill, Ruislip, Middx. Also note, we are not giving up any of our shop premises, so you will still be able to call at:

42-46, WINDMILL HILL, RUISLIP, MIDDX.

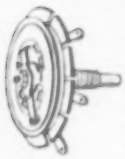
(Half-day closing Wed.)

152-153, FLEET STREET, E.C.4.

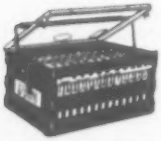
(Half-day closing Sat.)

ELPREQ PAGES

INDUCTANCE TYPE ATTENUATORS



High fidelity enthusiasts will confirm that an ordinary wire wound volume control in series with a speech coil introduces distortion. We have some inductance type attenuators wound in a very compact manner with heavy stud contacts giving reactance tappings as follows: off 42, 34, 23, 13, 7.9, 4.1, 1.7 0 ohms. You will see that these tappings have been chosen to enable the control to be calibrated in decibels. Price **4/6** each.



MILNES H.T. UNITS

120 volts 60 m.a. you charge these from a 6 v. car battery. Price 67.6 each—callers only or carriage at your risk.

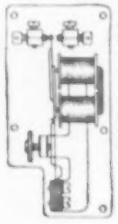
L.F. TRANSFORMERS

465 kc/s iron dust cores fitted in aluminium can size 1¼in. × 1¼in. × 3¼in. Price **12.6** pair.

Midget type, 465 kc/s size 1¼in. × 1¼in. × 1in. (M.400B). Price **17.6** pair. 465 kc/s.

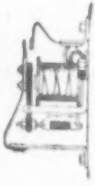
Ex-equipment in good condition fitted in standard size can, dust cored. Price 7/6 pair.

RELAYS



Extra light weight extra sensitive for high speed or radio control work, weight only 1¼ oz., closes on 2 mA., solid, platinum change-over contacts, adjustable pressure. Price **13/6.**

CONTACTOR



For breaking 25 amps, coil voltage is 24 v. D.C., but with a re-wind or a small rectifier these will close off A.C. mains. Very heavy duty solid silver Contacts. Price **3/6.**

PLUGS FOR MODERN VALVE HOLDERS

Each is fitted with a rubber shroud. Type 1, for B7G button base. Type 2, for B9A noval base. Price **1/4** each, discounts for quantities.

COMMUNICATIONS RECEIVER R.1155

YOURS FOR £4.17.6

We have just bought a new consignment of these and can guarantee them to be absolutely unused (not just in re-crackled case). This set as most will know is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F. so obviously a robust receiver which will give years of service. The price is **£14.10.-** or will be sent against deposit of **£4.17.6** and balance over 12 months. If you cannot call to collect please include an additional 10/- to cover cost of transit and carriage. This is partly returnable to you if and when you return the transit case.

MAINS POWER PACK FOR R.1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price **£5.10.-** complete with 5in. speaker ready to work, carriage 3/6.

VALVEHOLDERS

Type	Paxolin	Amphenol	Ceramic
	s d	s d	s d
British 4-pin	6	—	9
British 5-pin	6	—	9
British 7-pin	6	—	9
British 9-pin	9	—	—
UX 4-pin ..	6	—	1 6
UX 5-pin ..	6	—	9
UX 6-pin ..	7	—	—
UX 7-pin ..	8	—	—
Large UX7 ..	—	—	1 0
Diode B3G ..	6	8	—
B7G ..	6	8	10
B8G Loctal	9	—	—
B8A	1 3	1 6	—
B9A (Noval)	1 3	—	—
B9G ..	1 0	1 0	—
B12A (Duodecel)	1 3	—	—
Int. Octal ..	6	9	1 6
Mazda Octal	6	9	—
8-pin side Contact ..	—	2 6	—
Jumbo 4-pin	—	—	3 6
4-pin Hivac	9	—	—
5-pin Hivac	9	—	—
5-contact Acorn ..	—	—	1 6

VALVE SCREENING CANS

	s d
Suitable for standard size valves consists of three parts, bottom plate, main body and spring top	1 3
B7G fixing base and top screen with spring	1 6
Screen for octal G.T. Valves ..	6

VALVE RETAINERS

Spring type for EF50	3
Threaded type for EF50 ..	6
General type for all valves, consists of a silk cord and two springs	3

VALVE TOP CONNECTORS

Type	Plain	Scr'ned	Insulated
	s d	s d	s d
British ¼in. top ..	1½	9	1 6
American ¼in. type ..	1½	9	1 6
Screw to clip adaptor (for modern equivalents)			6

SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makers are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price £1 for the complete folder.

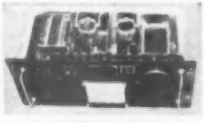
Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this Country. Names include Sparton, Emmerson, Admiral, Crossley, R.C.A. Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is £1. Post free.

EXTENSION SPEAKER IN METAL CABINET

This has a 6½in. P.M. Goodman's Speaker, heavy magnet type, complete with an output transformer. It is fitted in grey steel case with perforated front and back, ideal for P.A. work in canteens, clubs, etc., 27/6 each.

UNSPILLABLE ACCUMULATORS

Very best make clear celluloid case. Size 4¼ × 2¼ × 3¼in. 11 Amphour. Price **14/6.**



TUNING UNITS

American made units, available are TU5B, TU6B, TU9B, TU10B, TU13A, TU17A, TU25A, TU47, TU48, TU49, TU51, TU52, TU54, TU60. All **19.6** each, plus 3/6 carriage.

PYE PLUG AND SOCKET

6d. each part.

ENAMELLED WIRE
(On wooden reels.)

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	2/-
20	1/4	2/2
22	1/5	2/4
24	1/6	2/6
26	1/7	2/8
27	1/8	2/9
28	1/8	2/10
30	1/9	3/-
31	1/10	3/1
32	1/10	3/2
33	1/11	3/3
34	1/11	3/4
36	2/-	3/6
38	2/2	3/10
40	2/4	4/2

TINNED COPPER WIRE

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/5	2/-
20	1/4	2/2
22	1/5	2/5

DOUBLE SILK COVERED WIRE.

S.W.G.	2 oz. Reel	4 oz. Reel
16	1/3	1/10
18	1/3	1/11
19	1/5	2/3
20	1/6	2/6
22	1/8	2/10
23	1/9	3/-
24	1/9	3/-
26	1/11	3/4
27	2/-	3/6
28	2/1	3/8
29	2/2	3/10
30	2/3	4/-
31	2/4	4/2
32	2/6	4/6
33	2/9	5/-
34	2/10	5/2
35	3/-	5/6
36	3/2	5/10
38	3/6	6/6
39	3/8	—
40	4/-	7/6
41	2/3	—
42	2/6	—

A MILLIBAR BAROMETER

If you are interested in meteorology or if you think a good barometer would help you to explain some tricky radio problem, then you will be interested to know that an article appeared in one of the leading meteorological journals, showing how the Ex-R.A.F. Sensitive Altimeter can become a first-class highly sensitive yet robust aneroid barometer. We offer the sensitive altimeters in good condition with instructions at 17/6 plus 1/- postage.

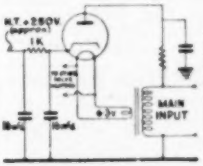
£5 FOR A FAULT

In all probability you have studied our last three "What's wrong—win £5" competitions, and you will have observed that symptoms have been given and readers have been invited to diagnose the fault. We invite you to submit 50 to 100 word articles suitable for this feature and offer £5 for the best, £3 for the second and £2 for the others we think suitable to use.

Note your article should be submitted on a separate sheet, but need not be in a separate envelope. It should reach us not later than September 30th.

CONSTRUCTORS' PARCEL, SPECIAL OFFER

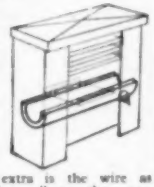
Modern design, bakelite cabinet in ivory, blue or brown, complete with metal chassis punched out for speaker and 5 valves, etc. Parcel also includes moulded perspex window, matched set of knobs, scale and hardboard back. Price 27/6, carr. and pkg. 2/6.



A POWER PACK FOR 15/-

Efficient power supply, O.K. for operating a receiver, amplifier, instrument or other device requiring up to 60 mA. at approx. 250 v. Parcel consists of filament transformer, rectifying valve, smoothing resistor and 16 × 16 mfd. 350 v. Electrolytic condenser. Note the filament transformer will supply enough current to operate 3 or 4 other 6.3 valves.

MAKE A CONVECTION HEATER



Using Ex-Admiralty HEATING UNITS fitted with 3 pin brass plug and socket. Copper-clad enclosed elements are used and these again are enclosed in sheet metal half cylindrical containers. Fit one of these into a metal cabinet, and you have an excellent convection heater. In places where appearance is not important, all you need extra is the wire as the heaters work perfectly well as they are, without extra casing the actual element being totally enclosed.

PRICES

2 K.W. 220/230 v.	12 0
500 W. 220/230 v.	12 0

Carriage 2/- extra per heater.

Sketches and details of suitable cabinet are supplied with each heater. 2 K.W. 110 v. heating units are also available at 7/6 each. These are ideal working in series for greenhouse heating, etc., or for space heating under benches, etc. Eight of these in series will consume 1 K.W. and will spread the heat out over a wide area.

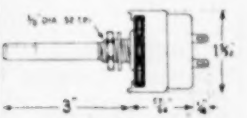
IDEAL GENERAL PURPOSE RECEIVER

The Elpreq "Wolsey" 5 valve A.C./D.C. superhet has a built-in aerial and is of convenient size and weight to carry from room to room. Powerful reception on long, medium and short waves—handsome wooden cabinet—illuminated glass dial, with station names—A.V.C. and usual refinements. Size 11in. × 5¼in × 7in. with B.V.A. valves, 12 months' guarantee. Limited quantity only. £9 5/- or £3 2/6 deposit and balance over 10 months, carriage and insurance, 5/-.

Orders by post are dealt with by our Ruislip depot. To avoid delay address to: E.P.E. Ltd., Dept. 2, Windmill Hill, Ruislip, Middx.

APPLIANCE LEAD

As fitted to H.M.V. appliances, it is 9ft. long, made of almost indestructible non-kink flex with rubber end support; ends are all prepared and bound. Price 2/9 each, 30/- doz.



VOLUME CONTROLS

We carry a full range of standard-size volume controls from 2K, to 2 meg. Prices are: less switch, 3/-; Single pole switch, 4/-; double pole switch, 5/-. We can also supply midget-type controls, less switch, 4/-; single pole switch, 5/9; double pole switch, 6/6. Each of these midget controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.

EBONITE TUBING

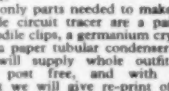
1in. external diameter, approximately ¼in. bore 9d. per ft.

RADIO STETHOSCOPE

A novel device aptly called a Radio Stethoscope is described in a recent edition of the "Radio Constructor," this is compact and can be slipped into the pocket rather like a fountain pen. With it in most districts a receiver can be checked from the grid of the first valve right through to the output without a signal generator, the stethoscope will operate in both L.F. and R.F. circuits without alteration. It is a complete fault finder.

The only parts needed to make the simple circuit tracer are a pair of crocodile clips, a germanium crystal, and a paper tubular condenser and we will supply whole outfit for 6/6, post free, and with each outfit we will give re-print of the article as it appeared in the "Radio Constructor."

NOTE.—If you wish to make it up as a pocket unit then you will need a few other odds and ends, solder tags, etc., from your spares box.



SHEET PAXOLIN

Invaluable for when you are experimenting. Size 6in. × 6in., 1/-. Size 12in. × 8in., 2/-. Size 12in. × 12in., 3/6. Size 24in. × 12in., 6/-.

Except for heavy and delicate items where carriage charge is specified, orders over £2 are post free. Under £2 add reasonable amount, bearing in mind a 15lb. parcel costs 2/-. Postable items can be sent C.O.D., additional charge 2/6. List 6d. Early closing days — Wednesday Ruislip, Saturday City.

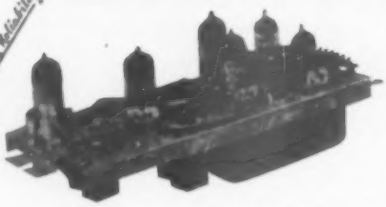
ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780
152-153 FLEET STREET E.C.4. Phone: CENTRAL 2833

LASKY'S RADIO

Retail Removal for Greater Reliability

TELEVISION SOUND & VISION STRIPS (B'ham frequency T.R.F.)



FULL CIRCUIT DETAILS AVAILABLE

Chassis size: 11in. wide, 3½in. deep, 4¼in. high (inc valves). 4 R.F. stages. (2 common to both sound and vision.) 6 new Mullard valves. (4 EF80, 2 EB91.) Suitable for AC/DC operation. Valves wired in series. Limited quantity. Produced by famous manufacturer.

ANNUAL STAFF HOLIDAY
All departments will be closed on Saturday, 27th September, and again on Monday, 29th September. Open as usual on intermediate days.

LASKY'S PRICE £6.19.6
Complete with all valves.
Carriage and packing 3/6 extra.

CONDENSERS

TUBULAR WAXED
500 v.w. .1, .01, .02, .05, .001, .002, .005, etc., etc. **6d.** each, 5/- doz.

MINIATURE MICA
100, 200, 300, 500 PF, etc. **6d.** each, 5/- doz.

CERAMIC AND SILVER MICA
All values from **4½d.** each, **4/-** doz.

MINIATURE
.1, .01, .001, .02, .002 mfd. etc. **7½d.** each, **6/-** doz.

MINIATURE BIAS
10 mfd. 25 v.w., **10½d.** each, **9/-** doz.

ELECTROLYTICS
32+32 mfd. 350 v.w. and 25 mfd. 25 v.w. in single aluminium can. Latest fixing, **4/11** each.

32+100 mfd. 450 v.w. condensers, **7/6** each.

32+32 mfd. 450 w.v. **6/11** each.

16+16 mfd. 450 v.w. **5/3** each.

8 mfd. 450 v.w. ..	2/3
8 mfd. 500 v.w. ..	2/11
8+8 mfd. 400 v.w.	4/6
8+16 mfd. 500 v.w.	5/3
8 mfd. 350 v.w. ..	1/6
16 mfd. 350 v.w...	2/6
50 mfd. 12 v.w. ..	1/11
25 mfd. 25 v.w. ..	1/11

.04 mfd. 12.5 Kv, latest plastic case, single bolt fixing, **7/6.**

EXPANDED METAL SPEAKER FRET
Metal finished silver. Size: 12in.×12in.
LASKY'S PRICE 3/11
Per piece.
Size 12in.×18in.
LASKY'S PRICE 5/11

PLASTIC SPEAKER FRET
Gold finished. Size: 12×16in., **6/6** per piece.

FOR CALLERS ONLY. 9 and 12in. C.R. TUBES
These tubes have either heater—cathode shorts and/or ion burns. They are ideal for experimental and testing purposes.
PRICE 35/- each.
A few only 12in. C.R. tubes faults as for 9in. tubes. Price 55/- each.

TAG STRIPS
Price **1d.** per way, i.e. 4 way **4d.**

ENGRAVED KNOBS
1 each: Tuning, Volume, L.M.S.G. and Tone. **4/-** the set of 4.

TOP CAPS
Screened, octal, **1/-.**
E.H.T. British, **1/-.**

E.H.T. BOOST KIT
Increase your E.H.T. Kit. Comprises a metal rectifier, 2 .001 mfd. condensers, and a 2-meg resistance. **20/-** The Kit. POST FREE.

TINTED SCREEN FILTERS
9-10in., **18/6.** 12in. **25/-.**

T.V. SCREEN ENLARGERS
9-10in. Clear or Filter, **55/-.** 12in. Clear or Filter, **75/-.** Carriage 3/6 each extra.

FOR CALLERS ONLY SPECIAL 10in. C.R.T. OFFER
Comprises 1 10in. C.R. tube, type 108K, with mask and glass to suit, Plessey scan coils, ion trap, and Elac focus magnet. **£14.19.6** complete.

ANTENNA ROD SECTIONS
Steel heavily copper plated. Each rod is 12in. long and ¼in. diameter, any number can be fitted together.
LASKY'S PRICE 2/6 per doz. **6/-** for 3 doz., **11/-** per half gross; **20/-** per gross. ALL POST FREE.

THE VIEWMASTER

METAL RECTIFIERS

WX3 and 6. Each	3/9
14D36	11/8
14A86	20/4
36EHT100 ..	29/6

SUNDRIES

Morganite resistances London	36/3
All other models	35/3
Bulgin components	13/2
Colvern pot/meters, Type CLR901,	3/2 each
Type CLR4089/22,	6/4 each
Morganite type "Q" pot/meters, 5/- each	
Belling Lee L707 and fuses	8/6

W/B & PLESSEY

Line EHT trans.	32/6
Frame trans.	35/6
3 Mc/s boost choke	5/9
Width control	10/-
Scanning coil	33/3
Main choke ..	15/6
Focus ring ..	22/6
Heater trans.: WB/103 ..	42/-
WB/103A ..	52/6
Front and rear C.R.T. supports	21/6

COILS
All models available including filter chokes. Wenvoe, Kirk o'Shotts, Holme Moss, Sutton Coldfield, 28/- per set. Alexandra Palace, 20/- perset. L9 RF choke, 2/-.

CHASSIS
Sound-Vision, **18/6.** Power-Pack/Time base, **18/6.** Support for S.V. chassis, **6/-.**

CONDENSERS
All by T.C.C.

100 mfd. CE10LE,	14/-
250 mfd. CE10DA,	10/-
2,500 mfd. 3 v.w. CE25AA ...	6/9
.001 mfd. 6 kV.	4/6
.001 mfd. 12.5 kV,	7/6

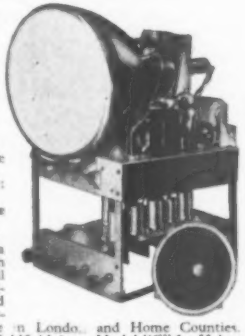
All other types in stock.
Also available T.C.C. VISCONOL .04 mfd. 12.5 kV., **7/6.**

VALVES
EF50 **4/3** and **8/6** each; EBC33, **12/6**; KT61, **12/10**; 6P25 **15/10**; 6K25, **15/1**; 6P28, **25/1**; EB92, **10/6**; EY51, **14/4.**

CATHODE RAY TUBES

New and unused, fully guaranteed. All makes available from stock for immediate delivery.
9" from **£13.13.8** 12" from **£18.4.10**
Let us have your requirements.

The television set you can build at home from standard parts.
Wenvoe, Kirk o'Shotts, Holme Moss, Sutton Coldfield and Alexandra Palace operation. Brilliant high definition black and white picture.
Superb reproduction.
Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.
Incorporates all the latest developments.
Television for the home constructor at its finest.
Send to-day for the CONSTRUCTION ENVELOPE, a 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions. Model "A" for use in London and Home Counties. Model "B" for use in Sutton Coldfield Area. Model "C" for Holme Moss. Model "D" for Kirk o'Shotts. Model "E" for Wenvoe.



PRICE Post free **7/6** per copy.

ALL COMPONENTS IN STOCK AND SOLD SEPARATELY.

LASKY'S

Lasky's (Harr
370 HARROW ROAD, PA
(Opposite Paddington Hospital) *Tele*
MAIL ORDER & DESPATCH DEPARTMENTS, 485/487

Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m.

Larger Screen T.V. new Wide Angle Components and Picture Tubes

14in. rectangular C.R. tube	£22	8	5
17in.	£26	19	8
16in. round, metal cone	£24	6	5

Carriage and insurance extra.

WIDE ANGLE COMPONENTS

Line and frame scan coils. Type DC300	£2	2	0
Width coil. Type GL18		10	0
Line linearity coil. Type GL16		10	0
Focus coil. Type FC302	£1	15	0
Line output and EHT transformer, 10-16 kV. Type L308	£2	10	0
Frame output transformer. Type FO305	£1	1	0
ELAC P.M. Focus magnets:			
For 14in. and 16in. tubes	£2	12	6
For 17in. tubes	£2	17	6

CIRCUIT DETAILS AND DIAGRAMS SUPPLIED.

C.P.T. MASKS. Brand new LATEST ASPECT RATIO

9in.	7/6
10in.	7/6
12in.	15/-
12in. flat face	15/-
15in.	15/-

SOILED OLD ASPECT RATIO

9in.	5/-
12in.	7/6
15in.	10/-
12in. with fitted armour plate glass (new ratio)	11/6

ARMOUR PLATE GLASS

12in. Actual size 13in. +10¼in.	4/-
9in. Actual size 9in. × 8in.	3/-

MULTI RATIO FRAME OUTPUT TRANSFORMER LASKY'S PRICE 10/6

FRAME BLOCKING OSCILLATOR TRANSFORMER LASKY'S PRICE 4/6

CO-AXIAL CABLE

Standard impedance.
Single screened, 1/- per yard.
Twin screened, 1/6 per yard.
Twin balanced feeder, 7½d. per yard. Post extra. Any length cut to your requirements. 10 per cent. discount on orders for 50 yards or more.

T.V. SCANNING COILS

Manfrs. surplus, high resistance frame, low resistance line. **12/6**

Low impedance line and frame. **14/6**

ION TRAPS

For Cossor 108K. 3/-
For Mullard..... 5/-

TELEVISION PRE-AMPLIFIERS

For London frequency. 2 Stage, uses 2 6F13 valves. Completely wired, ready for use. **LASKY'S PRICE 15/-** (less valves)

TRIODE FOCUS MAGNETS

Fitted with vernier control, 35 mm.
LASKY'S PRICE 13/-

TELEVISION SELENIUM RECTIFIERS

The very latest "Sentercell" S.T.C. range.

K3/40, 3.2 kV..	7/6
K3/45, 3.6 kV..	8/2
K3/50, 4.0 kV..	8/8
K3/100, 8.0 kV	14/8
K3/160, 12.8 kV	21/6

S.T.C. METAL RECTIFIERS

RM1	3/11
RM2	4/3
RM4	18/-

VCR97 C.R. TUBES. BRAND NEW AND UNUSED

In maker's original sprung wood transit case.
LASKY'S PRICE 40/-
Carriage 5/- extra.

E.H.T. TRANSFORMER FOR VCR97

Primary: 200-250 v., 50 c.p.s.
Secondary: 2.5 kV., 4 mA.; 4 v., 1.1 a.; 4 v. (CT), 1.5 a.
LASKY'S PRICE 45/-
Postage 1/6 extra.

6in. ENLARGER LENSES

Oil-filled plastic **19/6**
Carriage 2/6 extra.

BRANDENBERG R.F. E.H.T. UNITS

Output 6-9 kV. Brand new and unused. Supplied complete with EY51 and 6V6.
LASKY'S PRICE £6/6/-

RECEIVER UNIT TYPE 153

45 Mc/s I.F. STRIP. Contains 4 R.F. stages, detector video amplifier and phase splitter. Uses 6 EF50 and 1 EA50. Supplied complete with all 7 valves.
LASKY'S PRICE 63/-
Carriage 3/6 extra.

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS

(Cathode ray.) .001 mfd. 6 kV. Price 4/6 each. .001 mfd. 12.5 kV. Price 7/6 each.
.1 mfd. 7 kV. Price 15/- each.

C.R.T. REAR END PROTECTORS

Suitable for fitting to T.V. cabinets. 2/6 each.

8in. CLOSED FIELD LOUDSPEAKERS

Ideal for television receivers. Less o/trans. 3 ohms. Will not affect your C.R. tube. 17/6

VARIABLE INDUCTANCE WIDTH CONTROLS

3/6 each.

LARGE STOCKS of RESISTANCES ALWAYS AVAILABLE

All values. Prices: 1/10th and 1/8th watt, 7½d. each.
¼ and ½ watt, 4d. each.
1 watt, 8d. each.
Postage extra.

THE TELE-KING

Construction envelope using the latest 14, 16 and 17 inch cathode ray tubes, and wide angle components. Full size working diagrams and instruction booklet.

17 Valves. Superhet circuit for all channels.

PRICE PER COPY 6/-
POST FREE.

STOP PRESS!

"THE SOUNDMASTER"

The new tape recorder for home constructors. Constructional envelopes by the designers of the Viewmaster — write for full details.

DE LUXE TELEVISION CABINETS

For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster, "Practical Television," "Little Giant," "Practical Wireless," and "Wireless World" televisors.

LASKY'S PRICE £8 . 10
Carriage 12/6 extra.

Outside dimensions of cabinet: 17¼in. × 16¼in. × 32in. **Why not convert your table receiver to a console?** Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

RADIO

ow Road) Ltd.,
DDINGTON, LONDON, W.9.
phones: CUNningham 1979 and 7214
Harrow Rd., Paddington, London, W.10. Tel. LADbroke 4075.

TERMS: PRO Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

LASKY'S RADIO

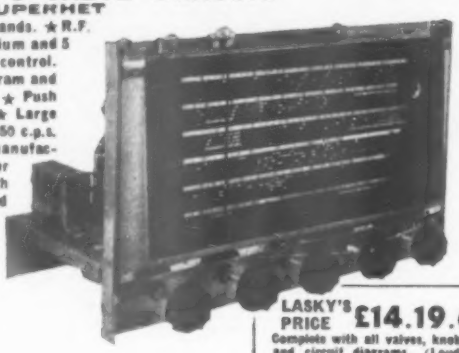
SCOOP!

BRAND NEW 9 VALVE CHASSIS

SUPERHET

★Band spread tuning on all bands. ★ R.F. stage. ★ 6 Wave bands, Medium and 5 short. ★ Variable treble-cut tone control. ★ Switched bass lift. (On both gram and radio). ★ Gram input sockets. ★ Push pull output, 6 watts. ★ Magic eye. ★ Large dial, 6 colours. ★ A.C. Mains 100-250v. 50 c.p.s. ★ Latest type valves. ★ By famous manufacturer. ★ Frustrated South African export order (Medium wave band calibrated in metres, with South African station names.) ★ Fully assembled, wired and aligned. ★ All valves and components fully guaranteed.

Write for full details, illustrations, and circuit diagrams.



TERRIFIC VALUE DON'T MISS THIS IT'S A SUPER SET!

LASKY'S PRICE £14.19.6

Complete with all valves, knobs and circuit diagrams. (Loudspeaker extra.)

Carriage, packing and insurance 17/6 extra

LASKY'S FUSED TEST PRODS

Safety First. The point of contact is fully retractable, and contact is not made until pressed.

LASKY'S PRICE 4/11 per pair.

ANNUAL STAFF HOLIDAYS

All departments will be closed on Saturday, September 20th and again on Monday September 29th. Open as usual on intermediate days.

COIL PACKS

3 wavebands, 12-35 metres; 35-100 metres; 200-550 metres. ¼in. spindle, 1¼in. long wave-change switch. Completely assembled and wired. Size: 4in. × 4in. × 3in. BRAND NEW AND UNUSED. LASKY'S PRICE 16/- Circuit available 6d. extra.

WEARITE I.F. TRANSFORMERS. Type 550

Permeability tuned, 445-520 Kc/s. Type 551. Critically coupled, with top grid connection. Type 552. Closer coupling for feeding diode circuit. Q115 inductance 700 microhenries at 465 Kc/s. Bandwidth of each of the above transformers is 7-20 Kc/s at 2-20 dbs. Size: 3¼in. high, 1¾in. square. Supplied with fixing screws and nuts. Per pair 12/6

INTER-COM. SETS

4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in pleasant plastic cabinet.

£8.19.6

Complete with one extension as illustrated.

INTERCOM EQUIPMENT

Master unit chassis. Comprises 16 + 16 mfd. 450 v.w. condenser, 2 Yaxley switches, input and output transformers, valveholders, etc. Less all valves and S.R. Switch, 15/-.

Cabinet for master unit. Pleasing walnut finish, 15/6.

Extension speaker cabinets. Similar in design to the master cabinet. For use with 3in. speakers, 9/11.

Carriage 2/6 per item extra.

J.RA.2. 10-12 WATT CHASSIS AMPLIFIER

For use on 200-250 volts 50 c.p.s. mains. Uses an L63 feeding 2 KT61's in push pull. U50 rectifier. Chassis size: 6in. × 17in. × 2in.

LASKY'S PRICE £7.19.6

Carriage 10/- extra.

Send 3d. stamp with name and address for details of the J.RA.2.

SPECIAL COIL BUY

Superhet dual wave coil, medium and long. Aerial and oscillator. For 465 kc/s. I.F. Supplied with circuit.

LASKY'S PRICE 2/11 Per pair. Post 9d. extra.

SHORT WAVE RANGES: Aerial and osc. for 465 Kc/s. I.F. S'het.

10-30 metres, 1/11 per pair.
25-95 metres, 1/11 per pair.

Circuit supplied with each pair. Postage 9d. per pair extra.

SPECIAL OFFER. 1 pair of each, 2 short and 1 medium wave.

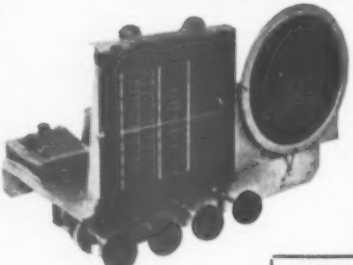
LASKY'S PRICE 6/9 Post free.

Size of coils: 1¼in. high, ¼in. diam.

SMOOTHING CHOKES

20 mA 40 H	3/11
40 mA 8 H	3/11
40 mA 10 H	4/3
100 mA 10-20 H	7/3
150 mA 5 H	3/6

ALL-WAVE RADIO CHASSIS!



- 5 new valves.
- 8in. Elac. p.m. speaker.
- Variable tone control.
- Large edgelit dial, 7¼in. square.
- 2-speed tuning with nylon drive.
- 4-watt output.
- Sockets for p.u. and extension speaker.
- 465 Kc/s. I.F.
- A.V.C.
- Circuit diagrams.

Size of chassis: 15¼in. wide, 8in. deep, 2¼in. high.

NOT A KIT, BUT A FACTORY-BUILT JOB. FULLY ALIGNED AND TESTED

LASKY'S PRICE £10.19.6

Complete with 5 valves and speaker.

Carriage and insurance 10/6 extra.

Enclose 2½d. stamp for full details, circuit diagrams and illustrations.

A limited supply of walnut plastic cabinets, suitable for use with this receiver is available at 45/-, carriage extra.

LASKY'S

Lasky's (Harr

370 HARROW ROAD, PA

(Opposite Paddington Hospital). Tel

MAIL ORDER & DESPATCH DEPARTMENTS 485/487

Hours: Mon. to Sat. 9.30 a.m. to 6 p.m., Thurs. half day 1 p.m

25-WATT AMPLIFIERS

Brand new, famous manufacturer's surplus. For use on 200-250 volts 50 c.p.s. mains. Absolutely perfect, uses 7 valves in all, with two 6L6's in push pull. Also includes a medium and long wave tuner unit.

LASKY'S PRICE £25 . 0 . 0.

Carriage and packing 25/- extra.

MAINS TRANSFORMERS

All 200-250 volts c.p.s. primary. Finest quality, full guaranteed.

MBA/3. 350-0-350 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. An ideal replacemen trans. Price 21/-

MBA/5. 350-0-350 v. 125 mA., 6.3 v. 4 a., 5 v. 3 a. With mains tapping board. Price 27/6

MBA/6. 350-0-350 v. 100 mA., 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6.

MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. Price 21/-

AT/3. Auto transformer. 0-10-120, 200-230-250 volts, 100 watt. Price 19/6

AT/4. Auto transformer. 100 volts and 230 volts. Step up or down. 60 watts. Price 9/6

FILAMENT TRANSFORMERS

Special Transformer. 30 volts at 2 amps., with the following tappings :—3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts, 21/-.

EX-A.M. FREQUENCY METER TYPE W1191A

BRAND NEW AND UNUSED. In makers' original wood transit case. Frequency range 100 Kc/s. to 20 Mc/s. continuous. Uses 4 valves and a 100 Kc/s. crystal. Battery operated 2 volt L.T. and 60 volt H.T. A few only left.

LASKY'S PRICE £8 . 19 . 6.

Carriage and packing 10/- extra.

VALVE SCREEN CANS

For button base valves.

LASKY'S PRICE 1/3 each.

VALVE SCREEN CANS

For octal valves.

LASKY'S PRICE 1/3 each.

TWO-GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature. With Perspex dust cover and trimmers. Size : 1¼ × 2 × 1¼in., ¼in. spindle **8 6**

LASKY'S PRICE

No. 2. Midget. With trimmers. Size : 2¼ × 1¼ × 1¼in., ¼in. spindle. **8 6**

LASKY'S PRICE

No. 3. Standard type. Size : 2¼ × 2¼ × 1¼in., ¼in. spindle. **6 6**

LASKY'S PRICE

THREE-GANG TUNING CONDENSER. .0005 mfd. Size : 3½ × 2¼ × 1¼in., ¼in. spindle. **7/6**

LASKY'S PRICE

TABLE MICROPHONE STANDS

Two section chrome plated. Crackle finished base.

LASKY'S PRICE 15 -

6-VOLT 90 A.H. CAR BATTERIES

Ex-American Army. Absolutely perfect, brand new and unused, in maker's original packing case. Size : 9in. wide, 7in. deep, 8in. high. In genuine hard rubber case.

LASKY'S PRICE £3 . 19 . 6.

Carriage 7/6 extra.

MIDGET YAXLEY SWITCHES

4 pole 3-way and 2 pole 5-way. Long spindle.

LASKY'S PRICE 2/11 each.

Postage 3d. extra.

EX-GOVERNMENT VALVES

VU120A	2/6	PT25H	5/2
VU111	3/6	E1148	2/6
APV4	12/10	RK34	2/6
57	3/6	MH14	4/6
32E	2/6	S130	4/6
	NGT1	5/-	

Tungar chargers recs. From 12/6. Screen grid, 2 v., 4/6 EF50's, 4/3 and 8/6 each, also 1D5 at pre-budget price of 11/-.

HUNDREDS OF OTHER TYPES IN STOCK.

PICK UPS

Acos GP.20. Including standard playing head ... 71/5
Long-playing head extra ... 43/4
Chancery GPX. Including standard playing head ... 53/-
Long playing head extra ... 31/6

P.M. LOUDSPEAKERS

All less o'trans. new and unused. First quality.

3in.	12/11
5in.	12/6
6½in.	12/6
8in.	14/6
10in.	
12in.	75/-

CARBON POT METERS

All with long spindle, ¼, ½, 1 and 2 meg

LASKY'S PRICE 3/3 less switch, each

With switch 4/3 each. All post extra.

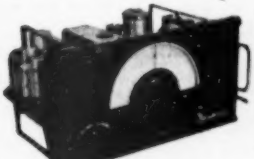
SPECIAL OFFER

BRAND NEW AND UNUSED R1155 RECEIVERS

AERIAL TESTED BEFORE DESPATCH

THESE SETS ARE THE TOPS

Supplied complete with 10 valves. Circuit : B.F.O., A.V.C., R.F. Amp., two I.F. Stages, magic eye, etc., etc. 5 Frequency ranges : 18.5-7.5 Mc/s. ; 7.5-3.0 Mc/s.; 1, 500-600 Kc/s. ; 500-200 Kc/s. ; 200-75 Kc/s.



SPECIAL REDUCTION

£11 . 19 . 6

Carriage 12/6 extra.

POWER PACK AND OUTPUT STAGE.

Fully assembled. For use with above receiver. Complete with valves, wired and working. For operation on 200-250 volts 50 c.p.s.

LASKY'S PRICE 79/6 carriage 5/- extra.

IF PURCHASED WITH R1155.

SOLD SEPARATELY, PRICE 99/6. carr. 5/- extra.

CAR RADIOS

BRAND NEW AND UNUSED

In maker's cartons

★12 volt. ★6 valves. ★R.F. Stage. ★L. & M. Waves. ★Black crackle finish. ★Tone control. ★A.V.C. ★Famous Manufacturer.

LIMITED QUANTITY ONLY.

£15 . 19 . 6

Carriage 10/- extra. Send for full details.

SOLON-HENLEY ELECTRIC SOLDERING IRONS

Brand new and unused. Supplied with fitted heavy rubber mains lead. Pre-Increase price. Oval Bit. For 230/250 volts only.

LASKY'S PRICE 19/-

Postage 1/- extra.

TOGGLE SWITCHES

S.P/D.T. On-off switch.

LASKY'S PRICE 1/- each.

FILAMENT TRANSFORMERS

All 200-250 v. 50 c.p.s. primary.

6.3 v. 1.5 a.	7/11
6.3 v. 3 a.	12/6
6.3 v. 4 a.	14/6
2v. 2a.	4/11

LASKY'S NEW RANGE OF POSTAGE STAMP TRIMMERS AND PADDING CONDENSERS

Paxolin	Ceramic
3-35 pf. 40-80 pt. 30-100 pf.	3-35 pf. 40-80 pf. 30-100 pf.
LASKY'S PRICE 6d. each 5/- per doz.	**LASKY'S PRICE 9d.** each. 7/6 per doz.

550 pf. and 350 pf. Ceramic.

LASKY'S PRICE 1/- each. 10/6 per doz.

METAL RECTIFIERS

6 v. 4 amps.	17/6
12 v. 4 amps.	17/6

12-VOLT MALLORY VIBRATOR PACKS

Output 150 v. 50 mA. Complete with synchronous vibrator. New and unused.

LASKY'S PRICE 20/-

Postage 2/- extra.

B.S.R. GRAM MOTORS

MU10. Single-speed motor. Without p.u., £2/18/-.

MU14. 3-speed motor. With ut p.u., £6/8/6.

GU4A. 3-speed motor, fitted with lightweight high fidelity crystal pick up. £9/19/11.

Carriage 5/- per unit extra.

A large stock of Collaro and Garrard gram units, single speed and three speed, single players and auto changers now available. Prices on request. Send us your requir ments.

COLLARO TAPE DECK MOTORS

Price 42/- each.

RADIO

ow Road) Ltd.,

DDINGTON, LONDON, W.9

phones: CUNningham 1979 and 7214.

Harrow Rd., Paddington, London, W.10. Tel. LADbroke 4075.

Terms: Pro Forma, Cash with Order, or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

EX AMERICAN AIR CORPS ANTENNA RELAY UNITS TYPE CBY 29125

BRAND NEW AND UNUSED. Contains a 0-5 m/A. M.c. meter, also relay, insulators, 0.75 amp. heating element, .. 50 pf. 5 kV., vacuum condenser, etc. In metal case, size : 4½ × 5 × 3½in.

LASKY'S PRICE 10/-

GARLAND

'THE GARLAND' TAPE RECORDER

£37/10/0

including a 1,200ft. reel of Scotch Boy Tape and a spare spool. Carriage, etc., 15/-. Crate £1 (not charged if you undertake to return carriage paid to us). No wiring or soldering to be done—just plug in and record and play back from Radio, mike or pick-up. Incorporating the new Lane Tape Table and the UE7 Amplifier, housed in a de luxe walnut veneered cabinet, and supplied complete with a 1,200ft. reel of tape and a spare spool.

★ **GARLAND KIT FOR THIS RECORDER £32 16s.** plus carriage and crate as above

Hear the others, then hear and buy the GARLAND TAPE RECORDER.

GARLAND KITS

All valves, components, wire sleeving, etc., included.
Chassis has all main components (transformers, controls, valve-holders, etc.) already mounted. Only wiring and soldering to be completed.
Small components (resistors, condensers, etc.) are supplied in envelopes numbered according to circuit diagram, thus eliminating colour code difficulties.
Group boards are used where advantageous.
Complete circuit diagrams, wiring diagrams and instructions are supplied.
Valves are guaranteed for 3 months, all other components guaranteed 6 months.

GARLAND KITS mean streamlined construction.

AMPLIFIER A.C.II

This popular amplifier is still available for those who desire good quality at a low cost. Output is 4 watts, and volume and tone controls are incorporated. High-grade output transformer. H.T. and L.T. supplies are from mains transformer. Amplifier wired and tested. Plus 5/- carriage. **£6.2.6.**

★ **GARLAND KIT FOR THIS AMPLIFIER £5/2/6.** plus 5/- carriage.

GARLAND ACIV AMPLIFIER

The finest amplifier at the price in the world. Maximum output 11.5 watts. Frequency response within 1 db from 20-30,000 c/s. Harmonic distortion (1 kc, 8 watts) less than .2 per cent.; 26 db feedback. High and low gain inputs. Bass, treble and volume controls. **Standard valves used throughout.**

15gns. plus 15/- carriage, etc.

★ **GARLAND KIT FOR THIS AMPLIFIER £13.** plus 15/- carriage.

See last issue for details of suitable TUNER UNIT

THE UE7 RECORD-PLAYBACK AMPLIFIER

An exceptionally stable magnetic recording amplifier for high impedance heads (Lane, Motek, Sonek, Burgoyne); specially recommended for use with the Lane Tape Table. High and Low Gain inputs, for mike, radio or pick-up. Bass and treble equalisation. Variable tone control. Neon recording level indicator and mains on-off indicator. Supplied completely wired and tested for use on A.C. mains, 200-250 v. complete with 8in. Elac P.M. speaker, and instructions for operation and simple connection to tape recorder. STANDARD VALVES USED THROUGHOUT **12 gns.** Plus 7/6 carriage, etc.

★ **GARLAND KIT FOR THIS AMPLIFIER £9/15s.** plus 7/6 carriage.

HIGH QUALITY AMPLIFIERS

LEAK "Point One" TL12.12 watt. **27 guineas.**
LEAK RC.PA.U remote control pre-amplifier. **9 guineas.**
LEAK "Vari-slope" pre-amplifier. **12 guineas.**
ACOUSTICAL QUAD 12 watt Amplifier (including pre-amplifier). **£35.**
ROGERS "WILLIAMSON" AMPLIFIER. **£31.**
ROGERS "RD BABY DE LUXE" including pre-amplifier. **£18.**
ROGERS "JUNIOR DE LUXE" 10 watt. **£26 10/-.**
ROGERS "MINOR" 4 watt. **£11.**

SCOTCH BOY HIGH COERCIVITY TAPE

is recommended for use with our recorder; additional 1,200ft. reels can be supplied at **35/-** each. Spare plastic spools can be supplied at **4/-** each.

THE NEW LANE TAPE TABLE

A new version of the popular "Lane". Three motors, very fast wind-on and rewind (under one minute); heads are high impedance on mu-metal laminations, with half-thou. gap, giving a half-hour playing time on each side of a 1,200ft. tape reel. Plus 10/- carriage. **£16/10/0**

CONNOISSEUR

Two-speed transcription quality motor and turntable. 33⅓ and 78 r.p.m. selected by a switch; 12in. diameter turntable; lapped phosphor bronze bearings; vibration-less synchronous motor. **£22/18/8.**

CONNOISSEUR. Super lightweight pick-up, with interchangeable heads for standard or micro-groove recordings, fitted with easily replaceable semi-permanent sapphire. Price complete with two heads. **£10/0/8.**

DE LUXE TAPE RECORDER CABINETS

Veneered walnut, to take UE7 Amplifier and Lane Tape Table. **£6**

MICROPHONES

Ronette B1.0 Crystal Microphone. **£2/12/0.** Ronette HM7 Crystal Microphone. **£3/7/6.** Lustraphone CS1Z Moving Coil Microphone with built-in matching transformer. **£5/15/0.** Table Stand, extra. **£1/1/0.** Acos Mic 22 Microcell Microphone. **£6/6/0.** Ronette 088 Ball Type Microphone. **£3/19/6.** Ronette RFC7 Microcell Microphone. **£8/15/0.** Ronette S742 Twin Microcell Microphone. **£9/5/0.**

"VIEWMASTER" TELEVISION

After three years this is still the only television receiver which may be constructed in the home without any knowledge of television. Instruction envelope containing booklet and stage-by-stage full size drawings, **7/6.** State whether for London, Birmingham, Holme Moss or Kirk O'Shotts.

COLLARO HIGH TORQUE MOTORS

4-pole shaded pole; 1,500 r.p.m.; for A.C., tapped 100-125 v. and 200-250 v. State if clockwise or anti-clockwise required. Ideal for tape recorders, fans, etc. **37/6**

TECHNICAL BOOKS.

We carry large stocks of books indispensable to the electronic engineer. All books previously advertised still available.

CLEAREX TELEVISION MAGNIFYING LENS.

9in. clear, 55/-; 9in. filter, 60/-; 12in. clear 75/-; 12in. filter, 80/-. Carriage and packing 5/- each on all types.

COLLARO RCSII SINGLE-SPEED AUTOCHANGER.

Non-mixing, plays eight 78 r.p.m. 10in. or 12in. records. Supplied with Acos made plug-in pick-up head incorporating sapphire stylus. Magnetic, price **£11/14/11**, incl. P.T. Crystal, price **£12/3/2**, incl. P.T.

COLLARO AC47 SINGLE-SPEED TURNTABLE AND MOTOR. Centre-drive governor controlled heavy induction motor, for A.C. 100-130 v. and 200-250 v., with 12in. turntable. Variable speed. Price **£6 12/4**, incl. P.T.

COLLARO AC514 RECORD PLAYER. For 78 r.p.m. records. Rim-drive motor, with auto. stop, turntable, pick-up with plug-in magnetic head. Price **£6/9/-**, incl. P.T.

EDISWAN 3-SPEED AUTOCHANGERS. Plays eight 78 r.p.m., ten 33⅓ r.p.m., or 45 r.p.m. records. Replaceable double-pointed sapphire stylus, **£23 13/-.**

LOUDSPEAKERS

We can supply from our large stocks many types of loudspeakers including Goodmans, Vitavox and Wharfedale products.

TAPEMASTER MAGNET RECORDING HEADS.

A new range of high-quality tape recording heads in chrumium-plated cases for single hole fixing. All types are designed for half track recording. Senior Record/Playback, 5,000 ohm, **45/-**. Junior Record/Playback, 3,000 ohm., **39/6**. Senior Erase Head, **45/-**. Junior Erase Head, **39/6**.

B.S.R. SINGLE-SPEED TURNTABLE AND MOTOR, M.U.15.

This very popular unit is again available. Shaded pole motor for use on 200-240 volt 50 c/s mains and rim driven 8in. diameter turntable. Price **£3.**

BROS, Ltd.

MONTROSE METER : Made by Taylor. 7 ranges, 0-6-30-150-300 v. A.C./D.C. 0-30-300-3,000 mA. A.C./D.C. and continuity test. Moving iron movement. Price £2 10 -.

TUNING CONDENSERS. 50pF max., 3-hole fixing, spindle diam. ¼in., spindle length 1in. 1/6 each. 160pF (0.00016 F max.) upright mtg., with 4 fixing feet, spindle diam. ¼in., spindle length 1¼in., 2/3 each. Standard 450pF two gang, with feet, 8/6 each.

I.F. TRANSFORMERS. Small size, 2¼in. x 1¼in. x 1in., 13/6 per pair. Made for us by a leading manufacturer.

UNDRILLED CHASSIS. In 20 s.w.g., bright mild steel : Four-sided, size 13in. x 7in. x 2¼in., 7/6 each ; two-sided with two straps, size 12in. x 4in. x 2¼in., price 3/9 each.

★ **CARTRIDGE FUSES :** Special offer 250 mA. 1¼in. at 2/6 doz. 750 mA. 1¼in. at 2/6 doz. Any other size or current rating, 6d. each.

★ **ROTARY ON-OFF SWITCHES :** Single pole on-off, 3 A. 250 v. Spindle length ¼in. from end of bush, 2/6 each.

VALVE HOLDERS

B3G, pax. with spring retainer, 1/- ; Polythene cradle type, 1/- ; B5, pax., 6d. ; black bakelite, 9d. ; bakelite baseboard type, 9d. ; B7, pax., 9d. ; Amphenol, 1/- ; B7G, amphenol, 9d. ; Int. Octal, amphenol, 9d. ; Loctal, amphenol, 9d. ; B8A, amphenol, 1/- ; B8G, amphenol, 9d. ; B9, pax., 9d. ; B9A, pax., 1/- ; B9G, pax., 6d. ; Ceramic or siliconised polystyrene, 9d ; B12A, pax., 1/- ; UX4, pax., 6d. ; amphenol, 9d. ; UX5, pax., 6d ; amphenol, 9d. ; ceramic, 1/- ; UX6, pax., 6d. ; UX7, pax., 6d. ; UX7, medium (for 1625, RK34, etc.), ceramic, 1/-.

CARBON RESISTORS

ONE-THIRD TO ONE-HALF WATT : 10, 13, 15, 22, 33, 39, 56, 68, 71, 73, 100, 150, 170, 180, 220, 250, 270, 330, 390, 400, 450, 470, 500, 530, 600, 680, 820, 1k, 1.2k, 1.5k, 2.2k, 3.3k, 3.9k, 4k, 4.7k, 5.6k, 6.2k, 6.8k, 7.5k, 8.2k, 10k, 12k, 15k 18k, 20k, 22k, 24k, 25k, 27k, 30k, 33k, 39k, 40k, 47k, 50k, 56k, 100k, 150k, 220k, 270k, 330k, 470k, 680k, 1m, 1.2m, 1.5m, 2m, 2.2m, 2.7m, 3.3m, 4.7m, 10m. All at 4d. each.

ONE WATT : 50, 56, 82, 120, 150, 240, 330, 390, 680, 1k, 1.5k, 2.2k, 3k, 3.9k, 4.7k, 5.1k, 5.6k, 6.8k, 10k, 12k, 18k, 22k, 24k, 27k, 33k, 68k, 70k, 80k, 170k, 330k, 390k, 470k, 680k, 750k, 1m, 2.2m All at 6d. each.

TWO WATT : 220, 1k, 2k, 2.2k, 3k, 3.3k, 4.3k, 4.7k, 6k, 10k, 12k, 20k, 22k, 27k, 30k, 47k, 50k, 68k, 2.2m. All at 9d.

FOUR WATT : 500k, 1/- each.

JONES PLUGS AND SOCKETS : Fitted with robust flat pins to handle substantial currents. Metal housing (screen) and cable entry on female socket as supplied, but can be changed over to male plug if required. Six-way plug and socket complete, 1/9. Eight-way ditto, 2/-. Ten-way ditto, 2/6.

PYE PLUGS AND SOCKETS : For ¼in., ⅜in., or ½in. coaxial or other screened cable. Plug and socket complete, 1/3 each, 12/- per doz., £6 per gross.

★ MAINS TRANSFORMERS ★

All primaries 200-220-240 v.

MT1 : 250-0-250 v. 80 mA., 0-4-6.3 v. 3 a., 0-4-5 v. 2 a., 20/- each.

MT2 : 350-0-350 v. 80 mA., 0-4-6.3 v. 3 a., 0-4-5 v. 2 a., 20/- each.

MT3 : 0-30 v., tapped to give 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., all at 2 a. The ideal model-maker's transformer, 19/6.

MT4 : Charger trnsfmr., 0-4 v. 4 a., 10 v. 4 a., 20 v. 3 a., 19/6.

MT5 : Auto : 0-10-120-200-230-250 v. at 100 w., 19/6.

137 : Heavy-duty shrouded ; 250-0-250 v. 120 mA., 6.3 v. 7 a., 5 v., 5 a., 37/6.

190 : Heavy-duty shrouded ; 350-0-350 v. 120 mA., 6.3 v. 5 a. C.T., 5 v. 5 a., 42/6.

CATHODE RAY TUBES

Electrostatic focussing and deflection ; 5in. diameter ; second anode voltage, 2 kV. max. ; intensifier, 4 kV max. Exactly as specified for the "Television Oscilloscope" described in the June and July issues of this journal. Brand new in original crate or carton, 32/6 each.

POTENTIOMETER OFFER

25k. miniature ½ watt preset carbon pots, 9d. each, 7/6 per doz., 30/- per 100, £12 per 1,000.

LARGE OUTPUT PENTODES. V.T. 46 (P.T. 25H), 4 v. heater. Used strapped to replace PX25, 4/- each.

THYRATRONS. Type NGT1 (CV1141), 4 v. heater, anode volts 350. Anode current, peak 1 a., average 200 mA. Control ratio 40 5-pin British base, with anode top cap, 6/6 each, 72/- per doz.

METAL RECTIFIERS

Type MR2, 125 v. at 100 mA. Two in series required for mains voltage. Price 4/- each. Type 14D 972, 250 v. 25 mA. (with reservoir condenser). Small size ideal for test equipment, also in place of 14D/36 in T.V. circuits. Price 6/6 each. 6 v. 1 a. half-wave (or full wave with C.T. trnsfmr.), price 5/- each ; 12 v. 1 a. bridge, price 8/6 each ; 12 v. 4 a. bridge, price 22/6.

SENSITIVE NEONS : 85 v. striking. SBC with centre contact. Ideal for record level indicator on tape recorders, mains indicator, etc., 2/6 each.

WAFER SWITCHES

For ¼in. dia. spindle. Length of spindle quoted from end of bush.

3p. 2w. ¼in., 1/9.
6w. parallelling ¼in., 1/9.
1p. 3w miniature ¼in., 1/3.
4p. 2w. miniature ¼in., 1/9.
1p. 10w., ¼in., 1/9
1p. 11w. ¼in., 2/-.
3p. 3w. miniature 7/16in., 1/9.
4p. 3w. miniature 2¼in., 3/6.
4p. 3w. ¼in., 1/9.
3p. 3w. ⅜ bush ¼in., 3/-

PRIORITY TO DEFENCE AND EXPORT ORDERS.

ALL GOODS NEW AND UNUSED, OTHERWISE STATED. GOODS SHOWN AS EX-EQUIPMENT HAVE BEEN FULLY TESTED AND ARE IN GOOD WORKING ORDER. **PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND ADDRESS.** POST ORDERS TO OUR DEPTFORD ADDRESS. EARLY CLOSING THURSDAY, OPEN ALL DAY SATURDAY.

FIXED CONDENSERS : (pF's) : Ceramic 2, 4, 15, 20, 27, 30, 50, 220, 350. All at 9d. 1,000pF, 1/-. Silver Mica : 10, 30, 50, 160, 170, 180 All at 6d. 200, 300, 1,500, 3,100, 9d.

Moulded Mica : 50, 75, 100, all at 6d. 300, 470, 1,000, 2,000, 3,000, 4,000, 4,500, 4,700, 5,000, 10,000, all at 9d.

CLOSE TOLERANCE SILVER MICA CONDENSERS : All plus or minus 1 per cent. 100pF, 400pF, 9d. each. 1,000pF, 1,400pF, 1/3 each 10,000pF, 1/6 each.

HIGH CAPACITY PRECISION MICA CONDENSERS. Accuracy plus or minus 0.5 (point five) per cent of stated value. Pure mica and copper foil or silver.

(a) 0.017970μF ... 1/3 (b) 0.023570μF ... 1/3
(b) 0.027400μF ... 1/6
(d) 0.040710μF ... 1/6 (di) 0.048010μF ... 1/6
(e) 0.055820μF ... 1/6
(f) 0.082910μF ... 1/6 (g) 0.087460μF ... 1/6
(h) 0.108435μF ... 1/9 (i) 0.123750μF ... 1/9
(j) 0.147000μF ... 1/9

Many standard values can be made up by parallel or other combinations of above, e.g., a : f) ... 0.1μF ; i) ... 6μF 1μF.

HIGH VOLTAGE MICA CONDENSERS : 0.1μF 1,500 v. wkg. Bakelite-cased upright mtg., 3in. x 2¼in. x 1¼in. overall, 2/- each. Ceramic pot type, 10C 2178, 0.0002μF 5 kv. wkg., high H.F. current, 2/6 each. Flat bakelite-cased type ZA2837, 0.001μF, 5 kv. A.C. test, 0.5 A. at 2-8 mc. ; size 3¼in. x 1¼in. x ¼in. ; suitable tx or tv, 1/9 each.

EX-GOVT. VOLTMETERS : 0-300 v. Square-flanged 2in. M.C. meters. Precision series resistor is separate, so can be used as 0-5mA meter 10/- each.

EPICYCLIC DRIVES. Reduction 5 : 1 for ¼in. spindle. Price 1/6 each, 12/- per doz. With 1¼in. diam. drum, 1/9 each, 15/- per doz.

TOROIDAL CERAMIC POTENTIOMETERS. 17k, 100 watt, 8/6 ; 2.4k, 50 watt, 6/6.

TOGGLE SWITCHES. SPCO, 250 volt, 2 amp., 1/9 ; DP on-off 250 volt, 1 amp. 2/3.

EX-GOVT POTENTIOMETERS

Value	Track	Wattage	Spindle length	Price
50	W/W	5	Pre-set	2/6
500	W/W	1	½in.	1/9
2k	W/W	3	Pre-set	1/9
2k	W/W	5	¼in.	2/6
3k	W/W	5	Pre-set	2/6
3k	Carbon trop	2	¼in.	1/9
5k	W/W	2	¼in.	2/6
8k	W/W	5	¼in.	2/6
10k	W/W	4	1in.	2/6
10k	Carbon trop	2	¼in.	2/-
20k	W/W	3	Pre-set	2/-
20k	W/W	5	1in	3/-
20k	Carbon trop	2	¼in.	1/9
25k	W/W	2	¼in.	3/-
50k	W/W earthed slider	3	¼in.	2/6
50k	Carbon Mini	¼	¼in.	1/6
100k	Carbon Mini	¼	¼in.	1/6
200k	Carbon	½	¼in.	1/9
1 m	Carbon	1	¼in.	2/-

All new and unused. Spindle diameter ¼in. in all cases. Quantity prices on application.

WIRE WOUND RESISTORS. 4 watt ; 27., 145, 150, 200, 250, 1/3 each. 6 watt ; 2, 5, 14, 30, 50, 90, 1/8 each. 10 watt ; 2.4, 25, 40, 350, 410, 950, 20k, 1/9 each. 12 watt ; 5, 90, 100, 120, 173 3.5k, 3.6k, 4.7, 11k, 15k, 20k, 25k, 30k, 47k 50k, 2/- each. 45 watt ; 14k tapped at 2k, 2/3 each. 200 watt ; 430, 10k, 20k, 50k, 3/- each. We have large stocks of the heavier wattage resistors ; quantity prices on application.

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SPECIAL OFFERS. Midget Mains Transformers (size approx. 2½-3-3in.), drop-through chassis type. Screened primary 220/240 v. 50 c/s. Outputs 250-0-250 v. 60 m/a., 6.3 v. 2.5 a. Suitable for 6×5 rectifier and up to 4 other valves. Only **9/9.** Small Filament Transformers 220-240 v. input, 6.3 v. 1.5 a. output **5/9.** New boxed ex-Govt. valves VR126 (4 v. 7-pin H.F. Pentode), **1/9** each.

BATTERY SET CONVERTER KIT. All parts for converting any type of Battery Receiver to A.C. mains 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v. 90 v. or 60 v. at up to 40 m/a., and fully smoothed L.T. of 2 v. or 1.4 v. at up to 1 amp. Price complete with circuit only **45/9.**

H.T. ELIMINATOR & TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformers, h.t. and l.t. rectifiers, smoothing electrolytic and resistor, adjustable charger resistor. Supplied complete with circuit. Only **25/-.**

BATTERY CHARGER KITS
To charge 6 or 12 V acc. at 3 A, **27/9.**
To charge 6 or 12 V acc. at 4½ A, **42/-.**
Above consists of transformer, bridge rectifier and adjustable resistor. Circuit supplied.

COAXIAL CABLE, 75 ohms, ½in., **11d.** yd.

DIAL BULBS, M.E.S. 6.5 V 0.15 A, 8 V 0.15 A, **6/9** dozen.

NEW EX-GOVT. VALVES

6K8G.T	6/11	12H6 Met.	1/11
7Y7	9/9	12SH7 Met.	9/9
954	1/11	OZ4	7/9
VU120A	2/9	EF50	6/6
4SH	7/6	VT61A	1/11
MHLD6	9/6	RK34	1/11

ELECTROLYTICS (Current production. **Not** ex-Govt.)

Tubular Types		Can Types	
8μF 350 V	1/6	16μF 450 V	2/9
8μF 450 V	1/11	24μF 350 V	2/11
8μF 500 V	2/9	32 mfd 350 V	3/9
16μF 350 V	2/3	32μF 450 V	4/3
16μF 500 V	3/9	40μF 450 V	4/3
24μF 350 V	3/6	50μF 350 V	4/9
32μF 350 V	3/11	8-8μF 450 V	3/11
8-16μF 500 V	5/3	8-8mfd 500 V	4/9
25μF 12 V	10d.	8-16μF 450 V	4/6
25μF 25 V	1/3	16-16μF 450 V	4/11
25-25 mfd 25 V	1/9	16-16 mfd 500 V	5/9
25 mfd 50 V	1/9	16-32μF 350 V	5/3
50 mfd 25 V	1/9	32-32μF 350 V	5/11
50μF 12 V	1/3	32-32μF 450 V	6/11
50 uF 50 V	2/3	50-50μF 350 V	5/11

CAN TYPES
32-32 8μF 350 V (small) **5/11**
16-16 8mfd 475 V **5/9**
32-32μF 350 V plus 25μF 25 V **4/11**
50μF 350 V plus 250μF 12 V **4/11**

CHASSIS. 16 swg. Undrilled Aluminium Receiver Type 10×5½×2in., **3/9**; 11×6×2½in., **4/3**; 12×8×2½in., **5/3**; 16×8×2½in., **7/6**; 20×8×2½in., **8/11**; Amplifier Type (4 sided), 12×8×2½in., **7/11**; 16×8×2½in., **10/11**; 14×10×3in., **12/6**; 20×8×2½in., **13/6.**

ALUMINIUM PANELS. 18 s.w.g. 18×12in., **5/6**; 18×18in. **8/3.**

SILVER MICA CONDENSERS. 5μμF, 10μμF, 15μμF, 20μμF, 25μμF, 30μμF, 35μμF, 50μμF, 150μμF, 156μμF, 180μμF, 200μμF, 240μμF, 300μμF, 330μμF, 400μμF, 470μμF, 500μμF, 1,000μμF (.001μF), 2200μμF (.002μF). All at **9d.** each. **3/9** dozen one type.

TUBULAR WIRE-ENDED CONDENSERS (New Stock). .001 mfd., 750 V, .002 mfd., 750 v., .003 mfd., 750 V, .005 mfd., 500 V, .01 mfd 750 V, .05 mfd., 450 V, .1 mfd., 350 V, .25 mfd., 350 V, .5 mfd., 350 V. All at **4d.** each, **2/9** doz. one type, **25/-** gross.

CABINETS, BAKELITE (Brown or White) or **WOOD** (Walnut veneered). Size approx. 12×6½×8in. Very attractive appearance. Supplied complete with fully punched T.R.F. 3-valve Chassis, back, 2 or 3 wave. Glass scale with coloured station names. Dial Backplate. **25/-,** plus carr. **2/6.**

YOU CAN BUILD a 2-wave T.R.F. receiver in above cabinets for less than £5. We can supply a pair of Weymouth 2-wave coils with circuit. Price **9/6.** We have good stocks of all items in the circuit drawing.

CLEARANCE LINES. .0005 mfd. 2-gang variables, **4/6.** Vol. Controls, Midget, 1 meg. with long spindle and S.P. switch, **2/9.**

EX-GOVT. ITEMS. Pye coaxial plugs and sockets, **7/6** doz. prs. Mansbridge type condensers, 4μF 600 V, **2/9.** Belling-Lee moulded type 5-pin and 10-pin plugs and sockets, **1/11** pr. Smoothing Chokes, tropicalised, 100 mA 8 H, 100 ohms, 50 mA 50 H 1,000 ohms, **4/6** each.

FOR CALLERS ONLY. Mains Trans., drop-through type with top shroud. Primary 230-250 v. Secs. 425-0-425 V, 200 m/a., 300-0-300 V 100 m/a., 6.3 V 2 a., 6.3 V 2 a., 5 V 3 a., **29/9.**

VOLUME CONTROLS with long spindles, all values, less switch **2/9,** with S.P. switch **3/11. WIRE WOUND POTS.:** 20 ohms, 2.5 K, 5 K, 20K, 50K (medium length spindles), **1/11.**

SELENIUM RECTIFIERS. 36 V 50 mA, **11d.**; 12-15 V 2½ A, F.W. Bridge, **12/9**; 12-15 V 4½ A F.W. Bridge, **18/9.**

P.M. SPEAKERS. All 2-3 ohms, 5in. F.W., **11/9**; 5in. Goodmans **13/9**; 6½in. F.W., **13/11**; 6½in. Goodmans, **15/9**; 8in. Plessey, **14/11**; 8in. Rola, **16/9**; 10in. Goodmans, **26/9.**

M.E. SPEAKERS. 8in. R.A. (2-3 ohms) Field 600 ohms, **12/9.**

R.S.C. MAINS TRANSFORMERS

Fully Guaranteed. Interleaved and Impregnated.

Primaries 200-230-250 V. 50 c/s Screened.

TOP SHROUDED, DROP THROUGH
250-0-250 V 70 mA, 6.3 V 2 A, 5 V 2 A, Midget type 2½-3-2½in. **15/6**
260-0-260 V 70 mA, 6.3 V 3 A, 5 V 2 A, **15/6**
260-0-260 V 80 mA, 6.3 V 2 A, 5 V 2 A, **15/6**
350-0-350 V 80 mA, 6.3 V 2 A, 5 V 2 A, **17/9**
350-0-350 V 90 mA, 6.3 V 3 A, 5 V 2 A, **21/9**
250-0-250 V 100 mA, 6.3 V 4 A, 5 V 3 A, **23/9**
300-0-300 V 100 mA, 6.3 V, 4 V 4 A, c.t., 0-4-5 V 3 A, ... **23/9.**
350-0-350 V 100 mA, 6.3 V-4 V 4 A, c.t. 0-4-5 V, 0-4-5 V 3 A, ... **23/9.**
350-0-350 V 120 mA, 6.3 V 4 A, 5 V 3 A, **29/9**
350-0-350 V 150 mA, 6.3 V 4 A, 5 V 3 A, **29/11**
350-0-350 V 150 mA, 6.3 V 2 A, 6.3 V 2 A 5 V, 3 A, ... **29/11.**

CLAMPED UPRIGHT MOUNTING
250-0-250 V 80 mA, 6.3 V 3 A, 5 V 3 A, **17/9**
250-0-250 V 100 mA, 6.3 V 6 A, 5 V 3 A, for R1355 conversion, **28/9.**
350-0-350 V 100 mA, 6.3 V 3 A, 5 V 2 A, **21/6**

FULLY SHROUDED UPRIGHT
250-0-250 V 60 mA, 6.3 V 2 A, 5 V 2 A, Midget type 2½-3-3in., **17/6.**
350-0-350 V 70 mA, 6.3 V 2 A, 5 V 2 A, **18/9**
250-0-250 V 100 mA, 6.3 V-4 V, 4 A, c.t., 0-4-5 V 3 A, **25/9.**
300-0-300 V 100 mA, 6.3 V-4 V 4 A, c.t., 0-4-5 V 3 A, **25/9.**
350-0-350 V 100 mA, 6.3 V-4 V 4 A, c.t., 0-4-5 V 3 A, **25/9.**
350-0-350 V 150 mA, 6.3 V 4 A, 5 V 3 A, **33/9.**
350-0-350 V 150 mA, 6.3 V 2 A, 6.3 V 2 A, 5 V 3 A, **48/-.**
350-0-350 V 160 mA, 6.3 V 6 A, 6.3 V 3 A, 5 V 3 A, **48/-.**
350-0-350 V 250 mA, 6.3 V 6 A, 4 V 8 A, 0-2-6 V 2 A, 4 V, 3 A, for Electronic Eng. Televisor, **67/6.**
425-0-425 V 200 mA, 6.3 V-4 V 4 A, c.t., 6.3 V-4 V 4 A, c.t. 0-4-5 V 3 A, suitable Williamson Amplifier, **57/-.**
425-0-425 V 250 mA, 6.3 V 6 A, 6.3 V 6 A, 5 V 3 A, **65/6.**
325-0-250 V 20 mA, 6.3 V 0.5 A, 6.3 V 1.5 A, for Williamson Preamplifier, **17/6.**

E.H.T. TRANS. 2,500 V 2-0-2 V, 2-0-2 V for VCR97, etc., **37/6.**

FILAMENT TRANSFORMERS
All with 200-250 V 50 c/s primaries: 6.3 V 2 A, **7/6**; 0-4-6.3 V 2 A, **7/9**; 12 V 1 A, **7/11**; 6.3 V 3 A, **10/11**; 6.3 V 6 A, **17/6**; 0-2-4-5-6.3 V 4 A, **10/9**; 12 V 3 A or 24 V 1.5 A, **17/6**; 0-5-6.3 V 5 A, four times, giving up to 24 V 5 A up to 12.6 V 10 A, up to 6.3 V 20 A, by series or parallel connections, **58/-.**

CHARGER TRANSFORMERS
All with 200-230-250 V 50 c/s Primaries: 0-9-15 V 1.5 A; **13/9**; 0-9-15 V 3 A, **16/9**; 0-9-15 V 6 A, **22/9**; 0-4-9-15-24 V 3 A, **22/9**; 0-9-15-30 V 3 A, **23/9.**

SMOOTHING CHOKES
250 mA, 8-10 H, weight 12 lb. **10/9**
250 mA, 3 H, 50 ohms **8/9**
200 mA, 5 H, 100 ohms **7/6**
100 mA, 10 H, 100 ohms **7/6**
80 mA, 10 H, 350 ohms **5/6**
60 mA 20 H, 1,000 ohms **5/6**
20 mA 50 H, 1,000 ohms **10/6**
1a .25 H, L.T. type **4/9**

ELIMINATOR TRANSFORMERS
Primaries 200-250 V 50 c/s, 120 V 40 mA **7/11**
120-0-120 V 30 mA, 4 V 1 A **12/9**

OUTPUT TRANSFORMERS
Midget Battery, Pentode 66 : 1 for 3S4, etc. **3/9**
Small Pentode, 5,000Ω to 3Ω **2/11**
Standard Pentode 5,000 ohms to 3 ohms **4/9**
Standard Pentode, 8,000Ω to 3Ω **4/9**
Multi-ratio 40 mA, 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull **5/6**
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω **18/11**
Push-Pull 10-12 Watts to match 6L6, PX4, 6V6, etc. to 3-5-8 or 15Ω **16/9**
Push-Pull 15 Watts to match 6L6, etc., to 3Ω or 15Ω Speaker **22/9**
Push-Pull 20 Watts, High Quality, sectionally wound, 6L6, KT66, etc., to 15Ω **51/9**
Williamson type exact to author's spec., **35/-**

WE CAN QUOTE FOR QUANTITIES OF STANDARD OR SPECIAL TYPES. S.A.E. PLEASE WITH ALL ENQUIRIES.

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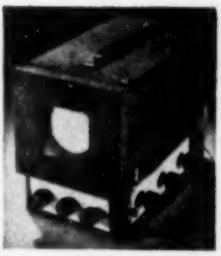
OSCILLOSCOPE TYPE 3BP1. We have pleasure in offering a 'scope designed primarily for simplicity and low cost at the same time giving reliable and consistent results. The Service engineer will find this an invaluable instrument due to its compactness, simplicity and speed of interpreting faults in radio receivers, checking transmitters, modulation, depth etc.



SPECIFICATIONS:

Amplifier: Max. Gain, Peak to Peak = .3 volts per cm. Frequency response 10 c/s — 100 k/c. Flat = 100 c/s to 50 k/c. Time Base: frequency range 5 c/s — 30 k/c.

Dimensions: 8½ x 6½ x 11½. Weight 17½ lb. Black crackle finish.

Price: Brand New, £14/14/0, carr. paid.

BOWTHORPE CONTINUITY METER. Dual scale 0-500 ohms and 100-200,000 ohms moving coil operated from 4½-volt internal battery. Size 6in. x 3in. x 4in. Original price £8.19/-. Our price, brand new, £4/4/-.

CONDENSERS. .1 mfd. 2,500 vw., metal or bakelite, 2/6. Electrolytic 8 mfd. 450 vw., 2/6; 8 x 8 mfd., 4/-; 16 mfd. 450 vw., 3/6; 16 x 16 mfd., 450 vw., 5/-. All midget tubular cans, cardboard sleeves, 60 mfd. x 40 mfd. 350 vw. size 4½in. x 1in., 7/6. Bias condensers 25 x 25 mfd., 50 x 12, 12 x 50, 1/6; 50 x 50, 3/-. All new stocks. NOT surplus.

TRANSFORMERS-FILAMENT. All inputs 200/250 v. A.3.

Output 6.3 v. 1.5 amps	7 6
Output 6.3 v. 2.5 amps	10 0
Output 6 and 12 v. 3 amps	£1 0 0
Output 6.3 v. 12 amps	£1 5 0

N.B.—Above voltages are when "on load."

MOVING COIL METERS (Brand New):—

0-5 mA. square panel mounting, 2in. scale	7 6
0-50 mA. square panel mounting, 2in. scale	7 6
0-40 v. square panel mounting, 2in. scale	7 6
0-20 amps square panel mounting, 2in. scale	7 6
0-300 v. square panel mounting, 2in. scale	12 6
0-40/120 mA. double reading round scale	12 6
2½in. round flush mtg., drilled flange:—	
Range 0/750 v. 200 ohms per v. each	£1 2 6
Range 0/1500 v. 250 ohms per v. each	£1 2 6
Range 0/3000 v. 200 ohms per v. each	£1 5 0

L.T. RECTIFIERS

6 v. 1 amp G.E.C.	4 0
12 v. 2½ amp Westinghouse	12 6
12 v. 4 amp S.T.C.	17 6
12 v. 8 amp S.T.C.	£1 12 6

S.T.C. RECTIFIERS E.H.T.

K3/25 650 v. 1 mA.	4 7
K3/40 1,000 v. 1 mA.	6 0
K3/100 8,500 v. 1 mA.	14 8
K3/200 10,000 v. 1 mA.	£1 6 0

H.T. RECTIFIERS

S.T.C. 125 v. 60 mA.	4 6
S.T.C. 125 v. 100 mA.	5 0
S.T.C. 125 v. 125 mA.	6 0
S.T.C. 250 v. 250 mA.	18 0
S.T.C. 300 v. 75 mA.	6 0
WESTINGHOUSE 14D 972, 250 v. 25 mA.	6 6
G.E.C. METER RECTIFIER, 1 mA.	11 6

WEARITE

705 Coil Pack 3 wave band	£1 17 10
400B Min. I.F.T. 465 kc. pair	15 0
501 and 502, 465 kc. pair	14 0
800's pair	15 0

PYE 45 Mc/s STRIP. Special purchase of M.O.S. Type 3583 Units. Size 15in. x 8in. x 2in. Complete with 45 Mc/s Pye strip, 12 valves, 10 EF50, EB34 and EA50, volume controls and hosts of resistors and condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price £5 carriage paid.

INDICATOR UNIT TYPE 192A. This unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF50, 6 SP61 and 1 5U4C valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. Scope constructional circuit included. Offered BRAND NEW (less relay) in original packing case at 79/6. Plus 7/6 carr.

STROBE UNITS. Brand new, in sealed cartons, these contain 6 EF50's, 1 5Z4, 5 EA50's, 1 SP61, a host of condensers, resistors, transformers, chokes, relays, switches, 7 pots and 5 smoothing condensers. Size 18in. x 8½in. x 7½in. Only 67/6, plus 5/- carriage.

RECEIVER R1355. As specified for "Inexpensive Television." Complete with 8 valves VR65 and 1 each 5U4G, VU120, VR92. Only 55/-, carriage 7/6. Brand new in original packing case. RF24, 25/-; RF25, 25/-; RF26, 59/6; RF27, 59/6. Owing to limited quantities, these units supplied only with R1355's.

CATHODE RAY TUBES:

VCR97. Guaranteed full picture. 40/-, carr. 5/-.
VCR517. Guaranteed full picture. 40/-, carr. 5/-.
3BP1. Suitable for 'scopes. 25/-, carr. 3/-.

RECEIVER UNIT TYPE 159. Size 8in. x 6½in. x 4½in., containing VR91, VR92, CV66, VR65 and 24 v. selector switch. New condition, 15/-.

WALKIE-TALKIE TYPE 46, complete with 6 valves. 2 VP23, HL23, DD QP25, TP25 and ATP4, aerial rods, I.F. trans., 1.6 Mc/s mike trans., in new condition but less transmitting components and coils removed by M.O.S. 35/-, carr. paid (less valves 14/-).

No. 38 "WALKIE TALKIE" TRANSRECEIVER, complete with throat mike, 'phones, Junction Box and aerial rods in canvas bag. Freq. range 7.4 to 9 Mc/s. All units are as new and tested before dispatch. As supplied to Overseas police forces. £4/19/6, carr. 2/6.

TUNING CONDENSERS

2 gang .0005 standard ¼ spindle, with trimmers	7 6
3 gang .0005 with ceramic insulation ¼ spindle	7 6
Midget two gang, .000375, with trimmers. Size 2in. x 1½in. x 1½in. Vanes enclosed in perspex	6 6
Midget .0005 mfd. 2 gang tuning condenser. Size only 2½in. x 1½in. x 1½in.	6 6
Or with built-in trimmers	7 6
Two-gang Midget .0005 with 4-way push-button assembly. Suitable for car radio, etc.	8 6

A COMBINED SIGNAL TRACER AND AUDIO OSCILLATOR. An easy-to-build unit that can be used for I.F. and Audio Signal Tracing, without any switching or tuning, including variable output oscillator for amplifier checking. Highly sensitive, responds to signals picked up from an ordinary receiving aerial.

The circuit is that of a high-gain 2-stage, resistance-coupled audio frequency amplifier, employing 3 miniature 1.4 valves, with a 3in. speaker in the Output of the Power Amplifier stage. An added advantage being that as this unit is "All-Dry" it can be used with safety on A.C. or A.C./D.C. mains and battery sets. The complete kit with portable cabinet (size 6in. x 7in. x 6in.) and battery weighs only 4 lb.

We shall be pleased to supply a complete kit for the construction of the above, right down to the last nut and bolt, including 2 1T4 and 1 1S4 valves, 3in. speaker and portable case and all-dry battery for £4/19/6. Concise instructions and circuits supplied. If preferred, circuit and instructions only can be supplied for 1/6. If required this unit will be assembled and tested for extra charge of 15/-. This is a highly efficient instrument, and a MUST for every radio man.

9in. ESCUTCHEON. Brown bakelite. Suitable plate glass and mask for 9in. tube. Price 7/6 each.

E.H.T. TRANSFORMER for VCR97. Input 230 v., output 2,500 v. 4 v. 2-0-2. 45/-.

E.H.T. TRANSFORMER for 5CP1. Input, 230 v., output 3,250 v. 6.3 v. .6 amp. 2-0-2 v. 45/-.

MAINS TRANSFORMERS. 250-0-250, 90 mA. 6.3 v. 3 amp, 5 v. 2 amp. Input 110 v./250 v. £1, post 9d.

EX-MANUFACTURERS. 350-0-350, 100 mA., 6.3 v. 4 amp, 5 v. 2 amp input 200/250. 25/-.

REPLACEMENT TYPE. 350-0-350, 90 mA., 4 v. 6 amps, 4 v. 3 amps, input 200/250. 18/6.

DUAL PURPOSE TYPE. 350-0-350, 80 mA., 6.3 v. tapped 4 v. at 3 amps, 5 v. tapped at 2 amps, 4 v. 2A/-, post 9d.

VR91 (EF50). Red Sylvanian. Brand new original boxes U.S.A., 10/-; Silver, brand new original boxes, British, 8/6; red or silver ex-units guaranteed, 6/-; 6A7, 12/6; 43, 12/6; VU111, VU120, VU120A, at 5/-; EF50 at 8/6; PX25 at 10/-.

WE STOCK ALL TYPES OF STANDARD CATHODE RAY TUBES and VALVES.

Send stamped addressed envelope for 28-page Comprehensive catalogue, price 3d.

OPEN MONDAY TO SATURDAY 9-5.30 p.m. (THURSDAY 1 p.m.)

THE A.C. MAINS R 1155 COMMUNICATIONS RECEIVER This famous Bomber Command Receiver now available complete with power pack, output stage, and speaker, ready to operate. Just plug in and receive the world, with a receiver of the £100 class. Wave ranges covered are 18.5-7.5 mc/s., 7.5-3.0 mc/s., 1500-600 kc/s., 500-200 kc/s., 200-75 kc/s. Every set is thoroughly tested and checked before despatch, and is BRAND NEW AND UNUSED IN THE MAKERS TRANSIT CASE. ONLY **£16 19 6** complete (carriage etc. 15/6) OR **BRAND NEW RECEIVER ONLY, £11 19 6** (carriage 10/6). **POWER PACK, OUTPUT STAGE AND SPEAKER** ready to plug on to any R 1155, ONLY **£5 10/-** (carriage etc. 5/-). BUY THE COMPLETE RECEIVING STATION AND SAVE 10/-.

I.F. STRIP TYPE 194. An easily modified I.F. Strip recommended for T.V. constructors who want good results at moderate cost, or for those who have built televisors but are having trouble in the vision or sound receivers. Can also be modified for 2 Channel working as per details in "Practical Television" October issue. This 6-stage strip measures 18in. x 5in. x 5in. and contains 6 valves: VR65, 1 of VR92, and 1 of VR53 or VR56. Mod. data supplied. BRAND NEW. ONLY **45/-** (postage, etc., 2/6).

RDF 1 RECEIVER. A very powerful 14-valve receiver with 4 I.F. stages of 12 mc/s. with 4 mc/s. bandwidth. Will convert into a first-class T.V. receiver for 2 Channel working as described in "Practical Television,"—October and November issues, a reprint being supplied. Valve line-up: 5 of SP61, 2 of P61, 3 of EA50, and 1 each CV63, EB34, EC52, 5Z4G. ONLY **49 6** (carriage, etc., 5/-).

10-VALVE 1½ METRE SUPERHET ZC/931. For long-distance T.V. results. Valve line-up is 6 of VR65, 2 of VR92, and 1 each VR136 and VR137 and the 12 mc/s. 6-stage I.F. Strip gives tremendous amplification with ample bandwidth of 4 mc/s. Easily modified. Full details supplied. ONLY **59 6** (carriage, 5/-).

INDICATOR UNIT TYPE 6. Contains 6in. C.R. Tube VCR 97, 4 valves EF 50, 1 of EB 34, and 1 of EA 50. The unit recommended for conversion to the "Wireless World" General Purpose Oscilloscope, full details supplied (or available separately 1/-). ONLY **79 6** (carriage etc. 7/6).

MODULATOR TYPE 67. Contains fully smoothed normal A.C. Mains power pack, transformer being 345 v.-0-345 v. at 200 ma., 6.3 v. 5 a., 6.3 v. 250 mA., 5 v. 2 a. Also contains 6 valves SP 61, 3 of EA 50, 2 of EB 34, and 1 of 5Z4. Complete in metal case, size 18in. x 8in. x 7in. ONLY **72 6** (carriage etc. 5/-).

"PYE" 45 Mc/s STRIP. The strip which ready made for London Vision Channel. Complete with 6 valves EF50 and 1 EA50 and details of very slight mods. necessary **ONLY 70/-** (postage, etc. 2/6).

100 MICROAMPS METER. 2½in. Flush Mounting. Widely calibrated scale of 15 divisions marked "Yards," which can be re-written to suit requirements. These movements are almost unobtainable to-day, and being BRAND NEW IN MAKERS CARTONS are a "snip" at ONLY **39 6.**

50 MICROAMPS METER. 2in. Flush mounting. Another movement which is in short supply and is also BRAND NEW IN MAKERS CARTON. ONLY **45/-.**

VCR 97 CR TUBES. All guaranteed tested full screen for Television use. In makers crates. ONLY **45/-** (carriage paid).

6in. MAGNIFYING LENS FOR VCR 97 TUBE. First grade oil filled. ONLY **25/-** (postage 2/-).

TRANSFORMERS. Manufactured to our specification, and fully guaranteed. Normal Primaries.
425-0-425 v. 200 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a., 0-2-4-6.3 v. 3 v. 3 a. ONLY **72 6.**
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a. ONLY **50/-.**
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a. ONLY **42 6.**
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a. ONLY **32 6.**
The above are fully shrouded upright mounting.
Universal Mounting 350-0-350 v. 80 mA., 0-4-6.3 v. 4 a., 0-4-5 v. 2 a. ONLY **18 6.**
Universal Mounting 250-0-250 v. 80 mA., 0-4-6.3 v. 4 a., 0-4-5 v. 2 a. ONLY **10 6.**
The following are upright mounting.
EHT for VCR 97 Tube, 2,500 v. 5 mA., 2 v.-0-2 v. 1.1 a., 2 v.-0-2 v. 2 a. ONLY **37 6.**
EHT 5,500 v. 5 mA., 2 v. 1 a., 2 v. 1 a. ONLY **72 6.**
EHT 7,000 v. 5 mA., 4 v. 1 a. ONLY **82 6.**
PLEASE ADD 1/6 PER TRANSFORMER POSTAGE.

TRANSFORMER. for a variety of uses giving outputs of 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., at 2 amps from normal mains input. ONLY **17 6** (postage 1/-).

TRANSFORMERS. Ex-W.D. and Admiralty, built to more than 50 per cent safety factor, with normal A.C. Mains Primaries. All Brand New and Unused.
300-0-300 v. 200 mA., 5 v., 3 a., 6.3 v., 5 a., C.T., 20 v. 750 mA., 70 v. 100 mA. Weight 12 lbs. ONLY **42 6** (postage etc. 2/6).
330-0-330 v. 100 mA., 4 v. 3 a. Weight 7 lbs. ONLY **22 6** (postage 1/6).
L.T. 5-0-5 v. 5 a., 5-0-5 v. 5 a., 5-0-5 v. 5 a. By using combination of windings will give various voltages at high current. Weight 11lbs. ONLY **35/-** (postage etc. 2/6).
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EHT 1,400 v. 2 mA., 520 v. 10 mA., 300 v. 10 mA., 2 v. 1.5 a. ONLY **21/-** (postage 1/6).

Cash with order please, and print name and address clearly. Amounts given for carriage refer to inland only

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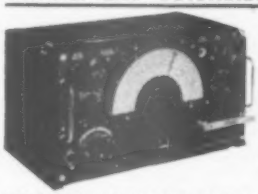
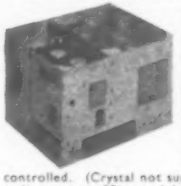


AIR MINISTRY COMMUNICATION RECEIVERS. R1155. We have just purchased from the Ministry of Supply a small quantity of good used receivers. Complete with valves and aerial tested before despatch. Complete with "Wireless World" 12-page data sheet. Now look at the price. **£7 10/-** each, plus 10/- for packing and carriage.

1155 POWER PACK AND OUTPUT STAGE. Not surplus. Complete with U50 and KT61 valves. Specially manufactured by us for the above receiver. Incorporates full power supply and output stage with built-in 5in. P.M. speaker and 'phone jack. Made to "Wireless World" specification. Connections terminate in Jones plug which simply plugs into receiver which is then instantly operated from 230 v. A.C. Housed in an attractive black crackle cabinet size 12in. x 8in. x 5in. which matches in appearance with receiver. Finest branded components only used throughout. Price **£7 10/-**, plus 3/6 carriage.



G.E.C. VHF 10-VALVE RECEIVERS. Complete with 10 valves as follows. H.F. and 1st Det. stages. ZA2, 954's or EF50's Local Oscillator DET 19. Three I.F. stages KTW63's Det. and A.V.C. D63, LF H'3, Output KT63. Noise suppressor D6s. Power requirements. 6 v. 3 a., 270 v. 80 mA. Available in three separate frequency ranges. Be sure to state which you want.
Range "A" 128-131 mc/s. "B" 95.5-100 mc/s., 78.5-82 mc/s. Intermediate Frequency adjustable 8.3-9.8 mc/s. Oscillator Crystal controlled. (Crystal not supplied.) Sensitivity 3 microvolts for 50 MW. audio output. 30% modulation at 130 mc/s. Input impedance 72 ohms. Housed in grey enamel steel case with lid 10in. x 8in. x 7in. Weight 22 lbs. Note the price, **49 6**, plus 5/- carriage. (We had to buy 400 to sell at this price.)

TELEVISION PRE-AMPLIFIER. Makes an amazing improvement in sound and vision in all fringe areas. Fitted with EF50 valve. Available for London. "A," Birmingham "B," Holme Moss "H," Scotland "S." Very small dimensions: length, 4in.; width, 3½in.; chassis depth, 1⅝in. Overall depth from top of valve, 4¼in. Power requirements 6.3 v. L.T., 200/275 v. H.T. Coaxial input and output sockets. Unique value. **10/-** post paid.
Available less EF50 valve if desired at **5/-**, post paid.

12-VOLT CAR RADIO. These are converted by us from the U.S. Navy Aircraft Radio Receiver CCT46106 (better known as BC455) and are fitted with suitable coils to tune the M.W. broadcast band. Six valves: 3/12SK7, 1/12SR7, 1/12K, 1/12A6. Fitted volume control and separate on/off switch. All controls on the set. No flexible drives.—Neat black crackle case 11in. x 4¼in. x 5¼in. Separate W.B. 5in. L.S. fitted with output transformer. Power supply from the silent motor generator mounted on rear of receiver. Current consumption under 2 amps. 2ft. aerial only required. Entirely brand new throughout. **£7 10/-**, carriage paid. (Not available for 6 v.)

VIEWMASTER TELEVISION COMPONENTS

EXCELLENT STOCKS.		PROMPT DELIVERY.	
WB200 Video Chassis	18/6	**Ediswan-Morganite Resistors:**	
WB101 Video Chassis Support	6/-	No. 40A London. 65 Resistors. Exact values	36/3
WB102 Time Base and Power Chassis	18 6	No 40B Midland. 63 Resistors. Exact values	35/3
WB103 Mains Transformer	42/-	No. 40C Holme Moss. 63 Resistors. Exact values	35/3
WB103A Auto Transformer	52 6	Ediswan Morganite Variable Resistance Type Q ... each	5/-
WB104 Smoothing Choke	15 6	Colvern Pots. Kit of 6	22/6
WB105 5707T Loudspeaker	32 6	Bulgin No. 7 Aerial Connector, Switch, Tag Boards, etc.	14/-
WB106 Frame Transformer	25 6	Belling Lee L707 Mains Connector Unit	7/6
WB107 Line Transformer	32 6	G.E.C. Neon Ind. Type G	3 6
WB108 Scanning Coil	33 6	**Viewmaster Coils and Choke:** London, 19/6; Midland or Holme Moss, 21/6; Viewmaster Envelope (specify area), 7/6; TCC Condensers. London. Exactly as specified, £7; Midland or Holme Moss	£7/7/-
PM Focus Rings. R25/6 for 12in. Triode	22/6		
WB110 Width Control	10/-		
WB111 Boost Choke	5/9		
WB112 Front and Rear Tube Support, 9in., 21/-; Ditto, 12in.	21/6		
Metal Rectifiers for Television: WX3 and WX6, ea. 3/7; 14A86, 18/3; 14D36, 11/-; 36EHT100	27/10		

We can give prompt delivery from stock of all items. All post paid.

200 Brand New Sperry Directional Gyros. 106A/170 (640370). For EXPORT only. Attractive Price.

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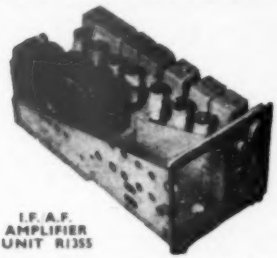
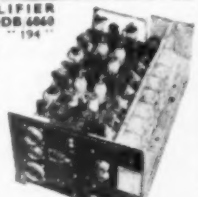


I.F. A.F. AMPLIFIER UNIT R1355

The popular T.V. Sound and/or Vision Unit. 5 I.F. stages, 10 valves 8/VR65 (SP61), 5U4G, VU120A, etc., etc. In metal case 18in. x 8¼in. x 7¼in. Used, good condition.
ASK FOR NO. X/E770 **67/6** CARRIAGE PAID
Circuit of R1355 available at 1/3

I.F.A.F. AMPLIFIER UNIT R1515 10DB 6060



Containing the "194" I.F. Strip. Suitable for Television experimental construction. Six stages of I.F. amplification. I.F. frequency 12.25 mc/s. Detector stage. 21 valves 6.3 v. filaments. 10/VR65 (SP61), 5/VR56 (EF36), 3/VR55 (EBC33), VR54 (EB34), VR53 (EF39), VR92 (EA50). In addition the unit contains hundreds of useful components, capacitors fixed and variable; resistors; potentiometers; Relays 10FB 650, 1,000 ohms, 3 make 1 break; 10FB 667, 1,000 ohms, 1 break, etc., etc.
Input points front chassis 18 pin plug, 12 way plug, 6 way plug, and 5 Pye type plugs.
Case size: 18 x 11½ x 7¼in.
ASK FOR NO. X/H72 **67/6** CARRIAGE PAID

JEFFERSON TRAVIS UF-2 TRANSCEIVER CHASSIS

Partly stripped by the M.O.S., less valves, tuning inductance, osc. connections, but otherwise fairly intact. A fine basis for a transportable type two-way radio. Original frequencies 60/75 mc/s. Valve types, 2/6Y7, 12J5. The unit comprises two chassis, with controls and speaker mounted on chrome plate etched steel panels, housed in cabinet finished black crackle.
Dim. 15¾in. x 18¾in. x 8¾in.
ASK FOR NO. X/H518 **£2** Each CARRIAGE PAID

CARBON POWER MICROPHONE

In original carton with transformer and leads (made by Tannoy). Requires only a loudspeaker and 12-volt acc. to make a portable P.A. equipment. Power consumption approx. 2 amps., output 4-5 watts.
ASK FOR NO. X/E894 **45/-** POST PAID

WIRELESS SET NO. 38 MK. 2. BRAND NEW

A haversack type transceiver range up to 5 miles. Frequencies 7.7 to 9 mc/s. 5 valves, 4 ARP12, ATP4, operated from dry batteries, H.T. 120 v., L.T. 3 v. (not supplied), complete with headphones, junction box, spares, satchel and instruction card.

FOR EXPORT ONLY

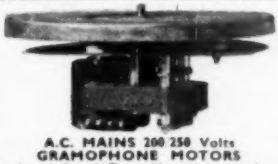
ASK FOR NO. X/H519 **£6.10.0** F.O.B. GLASGOW

NEW LIST NO. 8C

Giving details and illustrations of ex-service items and cancelling all previous lists and supplements.
Now Ready—Price 1/6.
Price credited on first purchase of 10/- or over.

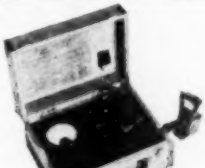
ROTARY TRANSFORMER Type 44
Ref.: 10KB 409

Input 18 volts, 2.13 amps. Output 450 volts 0.5 amps., with extension spindle both ends. Length 8¼in. x 3¼in. x 3¼in., finish grey.
ASK FOR NUMBER X/H845 **27/6** POST PAID



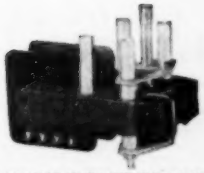
A.C. MAINS 200 250 Volts GRAMOPHONE MOTORS

Fitted with 9 inch Turntable and mounted on 8 inch metal plate, for crystal pick-up. Mfg. special line.
ASK FOR NO. X/H320 **58/6** Each POST PAID



FLUXMETER WY.0023

Designed to calibrate the field of Magnets within the range of 500 to 4,000 gauss and to determine their polarity. Complete with probe unit and contained in a hardwood case with hinged lid and handle. Instructions on lid. Dim.: 12¼ x 9 x 6in.
ASK FOR NO. X/H361 **£7.10.0** CARRIAGE PAID



A.C. MAINS INDUCTION MOTOR

for 100-120 or 200-240 volts. Ideal for models, recorders, etc. 4 hole fixing (with fixing screws). Spindle dia. ¼in., length 1¼in. Speed 1,500 r.p.m.
ASK FOR NO. X/H798 **27/6** POST PAID

PUMP DESSICATOR ADM. PATT. 12128 FOR TELESCOPES AND BINOCULARS

Hand operated complete with spare gel cell and conn. tubes. Stroke cap 480 c.cs., fitted humidity gauge, reads 10/100 per cent. vacuum gauge 0/30in. In wood transit case, 19½ x 12 x 9in.
ASK FOR NO. X/H358 **£5.10.0** CARRIAGE PAID

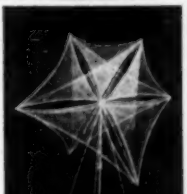
COOLANT PUMP BY PACKARD U.S.A.

A turbine type pump, directly driven from semi-ball joint splined socket (by motor not supplied), clockwise rotation.
ASK FOR NO. X/H407 **49/6** CARRIAGE PAID

BATTERY CHARGER

Rectifier type 42A. Ref. 10DB 1630.
A compact battery charger. Output 4 amps at 6 or 12 volts D.C. Input 230 v. A.C. 50 c/s, with ammeter, removable fuses, control switch for each circuit, input and output points, contained in well-ventilated black crackle metal case, dim. 12 x 8 x 6in. for wall or bench mounting.
ASK FOR NO. X/H715 **£5.19.6** CARRIAGE PAID

REFLECTOR AERIAL (MX-137 A) BRAND NEW



A First-class Transmitting and Receiving Omnidirectional Antenna in original moisture-proof carton with assembly instruction.
Heights assembled 6 feet approx. Width assembled 4 feet approx.
ASK FOR NO. X/E175 **8/6** Each POST 9d.

SMALL L.F. CHOKE

30H 50mA 400 ohms. Size 2¼in. x 2in.
ASK FOR NO. X/H806 **4/-** Each POST 9d.

TRANSFORMER: Type 110x 164

Made by United Transformer Corp. of New York. Small auto transformer winding resistance 500 ohms capped at 40 ohms. Ratio 5.5-1, in metal case size 2¼in. x 2¼in. x 2in., two-hole fixing.
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RECEIVERS TYPE R1155. Complete with ten valves, air tested and ABSOLUTELY BRAND NEW at **£11/19/6**, plus 10/6 carriage and packing in original transit case. Any set gladly demonstrated to callers.

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FEW ONLY. Slightly used R1155's, air tested, for only **£7/19/6** plus 10/6 carriage and case.

R1155 POWER PACK AND OUTPUT STAGE. Enables this receiver to be operated direct from A.C. mains. Just plug in and connect low impedance speaker (speaker not included), **£4/10/-**, postage and packing 3/6 extra. This unit is manufactured by ourselves from new components and valves, and is assembled in a neat black case 8½ x 6½ x 4in. All the necessary leads and Jones plugs supplied and included in the price.

SPECIAL OFFER of brand new R1155. Power Pack and output stage and brand new, boxed, 6½in. speaker for only **£17/10/-**, carriage paid.

COMMUNICATION RECEIVER TYPE CR100. (Marconi.) 2-R.F., P.C., Separate Local Osc., 3-I.F.s, 2nd Det. Output, B.F.O. and rectifier. Self contained mains power pack. Variable selectivity (crystal filter), 6,000, 3,000, 1,200, 300 and 100 cycles. Frequency range, six ranges, 60 Kc/s to 30 Mc/s. **The Set** for the serious operators, complete with valves and air tested, **£25.** Callers only. Only a few available.

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EF50 (VR91) RED SYLVANIA. Brand new at **8/6** each. British types, tested at 5/- each. Postage 6d. extra on 1-4 valves. Hundreds of other special purpose types in stock.

AMERICAN CONDENSERS. .01 mF 1,000 volts, .02 mF 750 volts at **7/6** per doz. .005 mF 1,000 volts, .002 mF 1,000 volts at **6/-** per doz. All metal cased tubulars, wire ended. Micamold ditto .1 mF 350 volts at **7/6** per doz. Small Mica Condensers—.001 MF CM20N at **6/-** per doz.

***BRAND NEW INDICATOR UNIT** in metal case size 18 x 8½ x 7½in. These employ your old favourite, the VCR517. This is a 6½in. electrostatic tube which can be used for 'scope work or gives an exceedingly pleasant picture when used for T.V. It is used in exactly the same manner as the VCR97 and employs the same voltages, base connections, etc. It does not suffer from cut-off and in our opinion gives a picture equal to, or better than, the VCR97. Call during evening hours and see for yourself. Complete with three EF50s, one SU4G, four SP61s, etc. (less relay). It is extremely cheap at only 79/6d. Carriage in original transit box 7/6d. extra. We supply "W.W." constructional details for 'scope free with each unit.*

100 MICRO-AMP. METER. 2½in. flush mounting. BRAND NEW IN MANUFACTURER'S ORIGINAL CARTONS. The scale is calibrated in "yards" but can easily be re-written. These are very scarce and are an exceptional bargain at only **39/6.**

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30 VOLT TRANSFORMER, standard primary—not surplus. Secondary 30 volts 2 amp. tapped to give 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Has countless uses, i.e., for battery chargers, filament trans., etc. price **17/6**, plus 1/- post. Brand new and guaranteed.

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Auto-wound, H.T. 280 volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separates 4 v. 3 amp., rectifier winding (upright or drop-through), 10/6.

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Auto-transformer, various combinations of voltages including 110 v. 70 watts, and 3/4 volt windings at 1 amp., 2 volt 1 amp., drop-through or upright mounting, 10/6.

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Pri. 230 v. Sec. 200-0-200 35 mA 6 v. 1 amp., 8/6.

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(Closed field)

	with trans.	less trans.
2½in.	—	13/6
3½in.	—	11/6
5in.	14/-	10/6
6½in.	14/6	11/6
8in.	16/-	12/6

P. and P. on the above 1/- each. 10in., less trans., 16/6. P. and P. 1/6.

R. & A. 8in. M.E. Speaker field coil, 1,600 ohms O.P. trans. 5,000 ohms, impedance, 18/6. Post and packing 2/-. Rola 5in. P.M. with O.P. trans., 16/6.

6½in. Energised Television Speaker by PLESSEY. Field resistance 68 ohms with hum-bucking coil. Will pass up to 300 mA., require minimum 200 mA. to energise. These are cheaper than a T.V. choke. 9/6 each, 2 for 18/-.

Volume Controls, by famous manufacturer. Long spindle less switch, 50K, 500K, 1 meg., 2/6 each. P. & P. 3d. each.

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8 x p a n d a d a l u m i n i u m speaker frat 13½ x 9in., 2/-.

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Trimmers, 5-40 pf., 5d.; 10-110 10-250, 10-450 pf., 10d.

Ceramic P.F.S. 3 each of the following: 330, 220, 180 and 82, 2/6.

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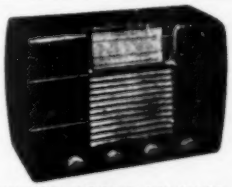

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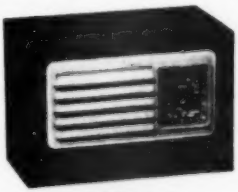
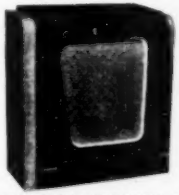


TWIN-GANG AND PAIR OF TRF COILS with circuit to suit above, 8/6.



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465 KC. MIDGET I.F.s. Q.120, size 1½in. long, 1in. wide, ½in. deep, by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6. Both these items £1, post paid.

CONSTRUCTOR'S PARCEL comprising 5-valve superhet chassis with I.F. and electrolytic cut-outs, size 13 x 6½ x 2½in., complete with 3-wave band scale (new wave lengths), size 11½ x 4½in. approx., drum, drive spindle, back plates, two pulley wheels and five International Octal Paxolin valve holders, 11/6. P. and P. 1/6.

CONSTRUCTOR'S PARCEL comprising chassis 8in x 4in. x 1½in., with speaker and valveholder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium, iron cored, four valveholders, 20 K. volume control and wave-change switch. 21/-.

6 IRON-CORED COILS on Aladdin formers 13.5-50 metres, 198-550 metres, 950-2,000 metres. Tuned with a .0005 gang, I.F. frequency 465 Kc. Complete with circuit, 8/6.

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 2 ohms speech coil, 4/9; 42-1 speech coil 2-ohm with extra feed-back winding, 4/3; Miniature 42-1 2-ohm speech coil, 3/3. Multi-ratio 3,500, 7,000 and 14,000 2-ohm speech coil, 5/6.

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32 x 32 mfd., 350 wkg. and 25 mfd., 25 wkg. 6/6
25 mfd., 25 wkg. 1/6d
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16 mfd., 500 wkg., wire ends 3/3
8 mfd., 500 v. wkg., wire ends 2/6
8 mfd., 350 v. wkg., tag ends 1/6
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Frame Oscillator Blocking Transformer, 4/6.

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P.M Focus Unit for any 9in, or 12in. tube, 35 mm. neck, except Mazda 12in., state tube 12/6.

Similar to above, but with front adjustment, 2/6 each extra.

Ion Traps for Mullard or English Electric Tubes, 5/-, post paid.

Pre-Aligned Midget 465 Kc. Q. 120, 9/- per pair, post 6d. **465 Kc. I.F.s**, size 2½ x 1½in. Q.110 removed from American equipment, 5/- per pair.

Iron-Cored 465 Kc. Whistle Filter, 2/6.

Standard 465 Kc. I.F.S, Q.120, iron-cored, 3½ x 1½ x 1½in., per pair, 9/6.

Television Masks. White Rubber, 9in. with glass, 7/6. Cream rubber, 12in. with armour plate glass, 15/-, 15in. white rubber mask, soiled, 12/6, plus 1/6 P. and P.

Valve Holders. Paxolin international octal, 4d. each. Moulded international octal, 7d. each. EF50 ceramic, 7d. each. Moulded B7G, slightly soiled, 6d. each. B8A, 7d. each.

Two-piece Octal Screening Can, 9d. P. and P. 3d.

Three-bank, 50 pf., 1/3. Four-bank, 50 pf., 1/6.

AMPLIFIER CHASSIS, 18 gauge aluminium, 5 valve holders, transformer and 2 electrolytic cut-outs, size 11½ x 7½in., sloping front, 4/- each.

Twin Gang Midget .00037 with perspex, dust-cover and trimmers, 8/6. Post and pkg. 6d.

Mains Droppers, 0.3 amp., 460 ohms, tapped 280 and 410, 1/6; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, 1/6; 0.3 amps., 950 ohms, tapped 700 and 825, 2/6; 0.2 amp., 1,000 ohms, vitreous, tapped, 2/6. Vitreous 3 amp. 700 tapped 680, 640, 600, 3/6. P. and P. on each 3d.

3-gang .0005 with separate 75 pf. on each section for S.W. tuning with feet, size 4½ x 3 x 1½in., 7/6.

Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquiries and Lists. S.A.E.

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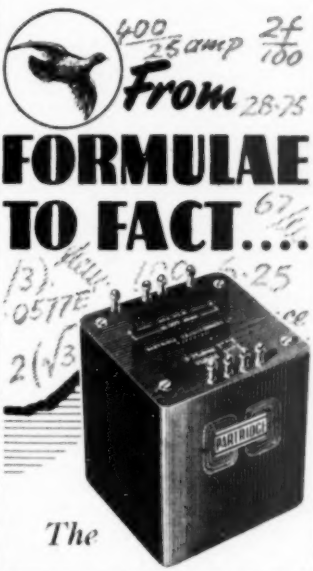

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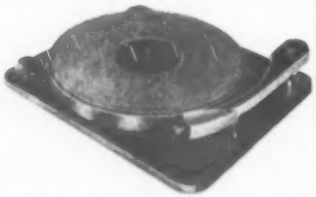

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12	2½	"	16 6
12	1	"	7 6
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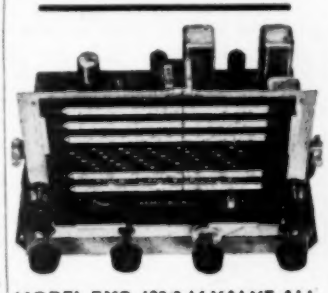

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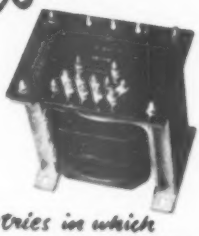

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PIPE-HAYES RADIO, 60a, Kingsbury Rd., Birmingham, 24. Tel. Erdington 4942. [8192

POLARISED relays required, types 4121, 4141, 4142, 299, 320; any quantity or condition.—Harris & Gillow, 93, Wardour St., W.1. [8868

WANTED, good class converter, 18 Mc/s upwards, 6.3 heaters; state ranges and I.F.s.—Richardson, 1, Hillbrow Rd., Ashford, Kent. [8879

WANTED, laboratory test equipment, including standard signal generator, watt meter, oscilloscope, bridges, recorders; send price and details to
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WANTED, spectrum analysers TS-148/UP (or TSZ-4SE), frequency meters, TS-33, 35, 36 AP (or TS-147/UP), oscilloscopes TS-34/AP, test antennae AS-105/APM-30, TEST sets AN/APM-5A (TS-45 and TS-76/APM-5), standing wave indicators TS-12/AP and sig. gen. TS-13/AP.—FLUXMETERS TS-15A/AP, sig. gen. TS-146/UP, also spare parts and components for ET-4336 and BC-610.—FOR immediate purchase.—British Sarotal, Ltd., 1, Bristol House, Southampton Row, W.C.1. [6906]

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THERE are prospects of promotion to senior draughtsman on salary scale £645 × £25—£765.
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THEY must have obtained the Ordinary National Certificate or equivalent, or have served at least 5 years in a drawing office. A knowledge of Ministry of Supply or Air Ministry procedure would be an additional advantage.
THE appointment will be unestablished in the first instance, but opportunities arise for establishment by examination.
FULLER details on application to Box 1708. [8899

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(B) WIRELESS Operator Mechanic (M.29587.B) required for the
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APPLY at once by letter, stating age, full names in block letters and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting on letter the reference number against the appointment for which application is made. The Crown Agents cannot undertake to acknowledge all applications and will communicate only with applicants selected for further consideration. [8910

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APPLICATIONS are invited for the post of electroencephalographic recordist-technician at the above hospital; the applicant should be familiar with low frequency electronic techniques; the post will involve taking records from patients and the maintenance of the recording apparatus; the successful applicant will receive a course of specialised training at the electroencephalographic section of the Department of Psychological Medicine, University of Durham, which will provide subsequent technical supervision.
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TESTERS.—N.W. London manufacturer requires exp. radio and tel. testers, good rates, 5-day week.—Ring Willesden 3902-5. [8880

TESTERS for final performance on electronic instruments. H.N.C. or equivalent; must have held similar position.—Write Box 1865. [8948

STOREKEEPER, must have thorough experience with all types instrument.—Wire Porchester Electrical, 15/16, Gerrard St., W.1. [8963

THE ENGLISH ELECTRIC Co., Ltd., Luton, invites applications for permanent posts in a laboratory engaged in development work involving radar techniques.
SENIOR and Junior positions are available to candidates possessing suitable qualifications and a knowledge of one or more of the following: (1) centimetric systems and measurements. (2) radar or television receiver practice. (3) mechanical layout and design work in connection with the above; salaries according to qualifications and experience in range £450 to £1,000; the laboratories are new and pleasantly situated.
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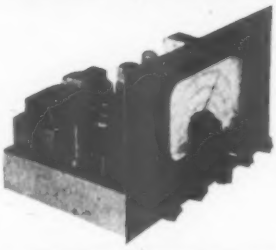

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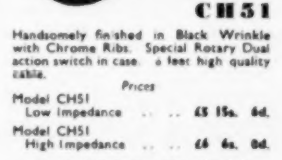

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SITUATIONS VACANT

SENIOR electronic engineer required, experience of helicopter instrumentation and analogue computors would be an advantage.—Apply, stating experience, age, etc., to the Personnel Officer, Saunders-Roe, Ltd., Southampton Airport, Eastleigh, Hants. [8851]

AN electrical engineer required for investigation and quality control work in radio valves and other electronic devices; Inter B.Sc. standard or equivalent.—Apply Personnel Superintendent, The Edison Swan Electric Co., Ltd., Cosmos Works, Brimsdown, Enfield, Middlesex. [8919]

RADIO and television service engineer required by old-established Murphy and Bush dealer; permanent post for the right man; write, giving full details and remuneration expected; interviews by appointment only.—W. W. Congdon, 11, Station Parade, Muswell Hill, N.10. [8916]

JUNIOR electronic engineer required to assist in development and testing of range of high quality electronic instruments; excellent opportunity for advancement in young and rapidly expanding organization; good salary offered.—Rivulin Instruments, 7a, Maitland Park Villas, N.W.3. [8862]

LABORATORY assistant required; must have had some experience with instrument inspection, wiring and general electronic testing, also previous experience in the use of simple A.C. bridges with a knowledge of electronics; 5-day week.—Apply H. W. Sullivan, Ltd., Leo St., Peckham, S.E.15. [8920]

ELECTRONIC instrument maker required, capable of high standard of wiring and skilled in various mechanical processes encountered in this field; opportunity for ambitious person to progress in young and rapidly expanding organization; good salary.—Rivulin Instruments, 7a, Maitland Park Villas, N.W.3. [8861]

A COST estimator is required by the Industrial Electronics Department of a well-known Midlands manufacturer; applicants should have good production experience in the radio industry and be capable of pre-production costing; write giving full details of previous experience and quoting reference IBC to—Box 1658. [8881]

MURPHY RADIO, Ltd., have vacancies for designer-draughtsmen in their electronics division; a varied programme ensures opportunity of widening experience with excellent prospects.—Apply giving particulars of training and experience to Personnel Manager, Murphy Radio, Ltd., Welwyn Garden City, Herts. [8904]

ELCONTROL Ltd., manufacturers of industrial electronic controls, have vacancy for tester also able to supervise small assembly group and assist with prototypes and specials; this is a ground floor job in a growing firm but experience of electronic manufacture essential.—Elcontrol Ltd., Wilbury Way, Hitchin, Herts. Tel. 1596. [8627]

GUIDED weapons development offers good opportunities for senior and junior electronic, electrical, radio and mechanical engineers; and draughtsmen, aerodynamicists, trials observers, technical authors, and computors (female); also for skilled and semi-skilled fitters, electronic wiremen, toolmakers and machine tool operators.
APPLY, quoting reference S.P. and giving particulars, qualifications and experience, to the Employment Manager, Vickers-Armstrongs Limited (Aircraft Section), Weybridge, Surrey.

GLOSTER AIRCRAFT Co., Ltd., of Hucclecote, Glos., have vacancies for electrical draughtsmen; previous aircraft experience an advantage but not essential; prospects are excellent for energetic and sound applicants.—Applications to be addressed to the Chief Designer, giving particulars of experience, age and salary required. [0226

TECHNICAL sales engineers required for training as overseas representatives for well-known British manufacturers of communication equipment; essential all applicants fully mobile with good general knowledge radio and television techniques and keen to sell; vacancies exist in most major overseas territories.—Box 1604. [8850

ELECTRONIC engineers for development test work on guided missiles, either for (a) electronic devices in the micro-wave pulse or communication field or (b) small electro-mechanical devices in conjunction with (a); applicants should normally have H.N.C. or equivalent, but others having suitable experience will also be considered.
TECHNICAL assistants are also wanted in connection with the above for prototype instrument assembly and wiring; applicants should have considerable experience either of prototype work on small electro-mechanical instruments, or of assembly and wiring of miniature electronic equipment; good salaries, 38-hour, five-day week; pension scheme.—Apply stating for which category, to the Asst. Manager (A), Research & Armament Development Division, The Fairey Aviation Co., Ltd., Dept. W, Heston Aerodrome, Hounslow, Middx. [8852

TECHNICAL Sales Manager required by large well-known company, in the Home Counties, qualifications to cover radio electronics, light electrical engineering and allied equipment; high level industrial contacts essential; salary commensurate with experience and qualifications; those not qualified to hold a four-figure post are requested not to apply.
APPLICATIONS, which will be treated in strict confidence, should be made in writing quoting reference J.80 to—Box 1640. [8894

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SITUATIONS VACANT

DEVELOPMENT engineers required for development laboratory of light engineering factory in Stockport; must have experience in circuit design for radio, test gear and electronic instruments. HNC, City and Guild's (Tele-communications) or degree essential; staff appointment, 5-day (39½ hour) week, canteen facilities. WRITE stating age and full details of experience and qualifications, Box 1191. [8796

YOUNG man, interested in music and having completed Military Service, required to take part in quality control applied to gramophone record processes; work is interesting and offers prospects of advancement.—Apply, stating age, salary required and particulars of previous employment, to Personnel Dept., E.M.I. Factories, Ltd., Hayes, Middx. [8689

DESIGNERS and draughtsmen for aircraft electrical installation work; applicants should be experienced in wiring, layouts, design of electrical junction boxes and switch gear, etc.; previous aircraft experience not essential.—Apply in writing, stating experience, age and salary required, to Chief Draughtsman, the de Havilland Aircraft Co., Ltd., Hatfield, Herts. [8452

EXPERIENCED high-class electronic fitter wiremen required for research and development work at The English Electric Co., Stafford, ex-H.M. Forces personnel with experience of radio and radar considered; good working conditions, canteen facilities, non-contributory life insurance and pension schemes, eligibility according to rules, hostel accommodation available.
APPLY quoting Stafford M. of L. Order No. 56 to Ministry of Labour and National Service Office, Stafford, or any M. of L. Office. [8858

TECHNICAL assistant.—The aircraft design technical office of the Bristol Aeroplane Co., Ltd., have a vacancy for a junior or intermediate technical assistant in their engineering development laboratory; the work is concerned with the vibration testing of aircraft structures and mechanical systems on an interesting range of civil and military aircraft and helicopters.
CANDIDATES should possess a Higher National Certificate in electrical engineering or equivalent qualification.
APPLICATIONS should be forwarded to the Ministry of Labour and National Service, 20, Nelson St., Bristol, 1, and marked for the attention of the Personnel Manager, The Bristol Aeroplane Co., Ltd., Aircraft Division, Filton House, Bristol. [8914

SENIOR and junior development engineers required for research work in radio and television development laboratories; applicants for senior position should be able to undertake development work with minimum supervision; excellent conditions and salary available for applicants who are accepted.—Apply in first instance to Chief Engineer, Radio Division, McMichael Radio, Ltd., Wexham Rd., Slough, Bucks.

TECHNICAL writer required for the preparation of equipment manuals, technical Press articles and other publications relating to radio aid to navigation. This post offers wide scope to a qualified electronic engineer able to assimilate and expound upon the fundamentals and details of an advanced c-w phase comparison technique, and with marked ability in the ab initio production of technical literature.
A SALARY commensurate with these qualifications is offered.
APPLY in writing to the Survey Section, The Decca Navigator Co., Ltd., 1-3, Brixton Rd., London, S.W.9. [8905

ENGINEERS for the maintenance of digital computers are required by the computer section of Ferranti Ltd.; applications are invited from engineers experienced in the servicing of large electronic equipments such as radar systems and predictors. Courses of instruction will be given to successful applicants, who will normally be based in Great Britain, although there will be opportunities for tours of duty abroad.
INITIAL salary in accordance with experience and ability in the range £450-£700 per annum; the company has a staff pension scheme.
APPLICATION forms from Mr. R. J. Hebbert, Staff Manager, Ferranti Ltd., Hollinwood, Lancs. Please quote reference D.C. M.E. [8766

ELECTRONIC engineering company, Teddington area, requires electronic engineer with wide knowledge of industrial electronics, including pulse techniques, to take charge of development of new equipments; well-established company; salary £1,250 plus; good chance of becoming technical director as present technical director will be going abroad to start foreign branch.—Please state education and experience to Box 0808. [8726

ENGINEER or physicist experienced in radar is required for work in connection with flight trials of airborne and radar equipment; degree or Higher National Certificate required; experience of aircraft and flying desirable, but not essential.—Apply in writing to the Staff Manager (Ref. GBLC/S.994), Research Laboratories of The General Electric Co., Ltd., North Wembley, Middlesex, stating age, qualifications and experience. [8926

LABORATORY engineer required for design and development of H.F. testing equipment for coaxial and telephone cables; engineering or physics degree essential and approximately 2 years' experience desirable; 25 to 26 years of age; £440 to £600 per annum according to qualifications and experience.—Write stating qualifications and experience to Personnel Manager, Standard Telephones & Cables, Ltd., North Woolwich, E.16. [8864

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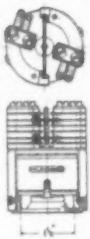

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SITUATIONS VACANT

ASSISTANT Foreman required, West London area, for electronic equipment section, good opening, with prospects, in important company for young engineer with at least O.N.C. standard of electro-technical training and experience in the construction, assembly and wiring of high-grade equipment or instruments, please write stating age, education, details of technical training and experience, also salary required.—Box 1634. [8868

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster General's First-Class Certificate of Proficiency in Radiotelegraphy; selected candidates will be considered later for permanent, pensionable posts.—Application should be made to any local office of the Ministry of Labour and National Service, quoting Order No. City 4728. [8956

TELEVISION cameraman required for employment in Canada, with expert handling knowledge of image orthicon camera equipment, experience in studio lighting, vision control, sound mixing and equipment maintenance desirable; applicants must be capable of undertaking complete responsibility for the work involved; adequate salary and good prospects are offered, write with full particulars of age, education and practical experience to—Box 1637. [8874

DEVELOPMENT engineers, International Aeradio, Ltd., specialists in equipment design for aviation service, due to expansion of development section at Heywood Airport near Watford, require junior and senior radio and telegraph engineers. Salary according to experience, single quarters provided, pension scheme, 5-day week, canteen facilities.—Please apply through Local Labour Exchange to Personnel Officer, 40, Park St., London, W.1.

THE ENGLISH ELECTRIC VALVE COMPANY, Chelmsford, Essex, has several attractive vacancies for graduates to undertake research and development work on vacuum tubes; applications from graduates who have recently qualified as well as those with industrial or research experience will be considered.—Please write giving full details, quoting reference 419, to Central Personnel Services, English Electric Company Ltd., 24-30, Gillingham St., S.W.1.

VACANCIES exist for senior and junction electronic engineers, on work in connection with the electronic measurement of physical variables and associated problems; this consolidation and expansion of a young department offers scope for men with enterprise and ability.—Applications, stating age, full details of qualifications, experience and salary required, should be addressed to the Personnel Officer, Saunders-Roe, Ltd., East Cowes, I.o.W. [8855

TELEVISION service engineer to take charge of modern service dept.; must be first-class trouble shooter, with theoretical and practical experience on Murphy, Bush, Pye, H.M.V., Ekco, etc., able to give guidance to those under him, commencing salary £12 10 per week, with opportunity of advancement; Murphy dealer, S.W. London; also 2 television engineers, able to drive, must be experienced, commencing salary £8 10 per week.—Apply in first instance to Box 1820. [8925

DRAUGHTSMEN, senior and intermediate, required in London, W.12, by important company manufacturing light electro-mechanical and electronic equipment; applicants should have experience in this field including electronic components layout; one post requires some experience super-sonic equipment; also knowledge of shipboard practice an advantage; please write giving details of experience, age and salary required; good conditions of employment and pension scheme.—Box 1635. [8869

JUNIOR electronic engineer, well versed in fundamental theory, required by the English Electric Company, Ltd., Luton, to work in a new department on specialised equipment employing new techniques, previous experience unnecessary, but initiative, ability to improvise and adaptability most important, salary according to qualifications.—Please write, giving full details and quoting reference "English Electric 415," to Westminster Employment Exchange, Chadwick St., London, S.W.1. [8812

GENERAL Electric Co. have 2 vacancies for graduates for work at Stanmore; (a) an experienced man is required to take major responsibility for the design and operation of system test apparatus to be used in connection with airborne radar equipment; (b) physicist or engineer for work on electronic simulators.—Apply in writing to the Staff Manager (Ref. GBLC/S/995), Research Laboratories of The General Electric Co., Ltd., Wembley, Middlesex, stating age, experience and qualifications. [8927

AERONAUTICAL service engineer required, duties will include installation, flight testing and servicing, for which a thorough practical and theoretical knowledge of A.C. and D.C. amplifier systems is required; a knowledge of electro-mechanical servo systems and synchronous transmission systems would be an advantage; preferential consideration will be given to applicants with previous electronic experience in possession of H.N.C. (or equivalent) or who have served a recognised engineering apprenticeship with subsequent experience in technical capacity; must be prepared to travel; position will be permanent and pensionable after qualifying period; commencing salary £450 p.a. —Apply with full details of age, qualifications and experience to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Rd., Brentford, Middlesex. [8929

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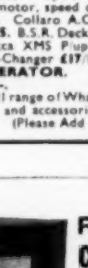

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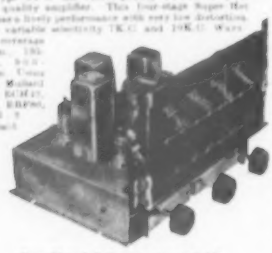

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RADAR Handbooks.—Engineers required for the preparation and/or editing of technical reports on radar and allied electronic equipment; applicants must have sound knowledge and practical experience of modern radar equipments and be capable of producing reports in clear, concise and good English; they should also possess a marked critical faculty to enable them to detect errors and omissions; those earning less than £700 per annum need not apply.—Applications should be made in writing, to Box 1605. [8035

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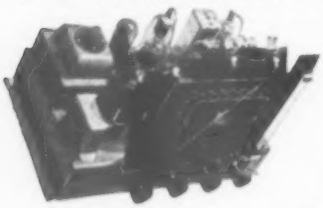

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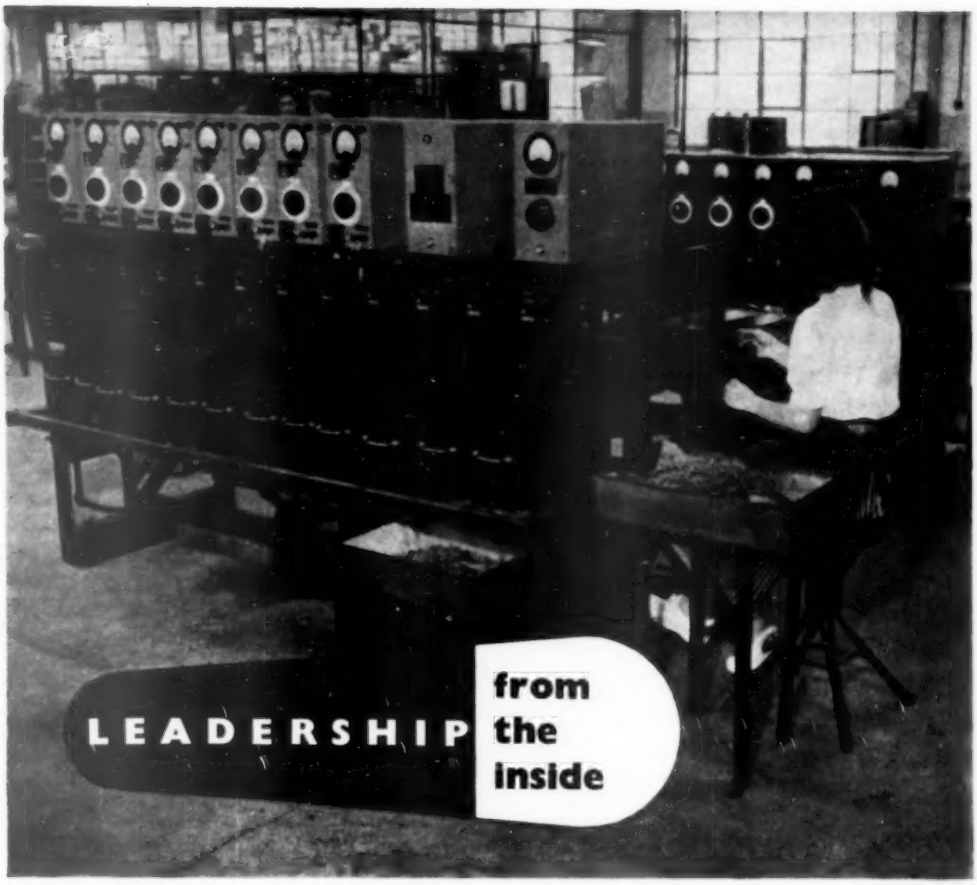

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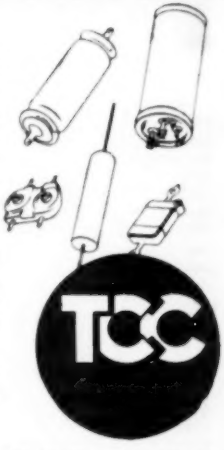

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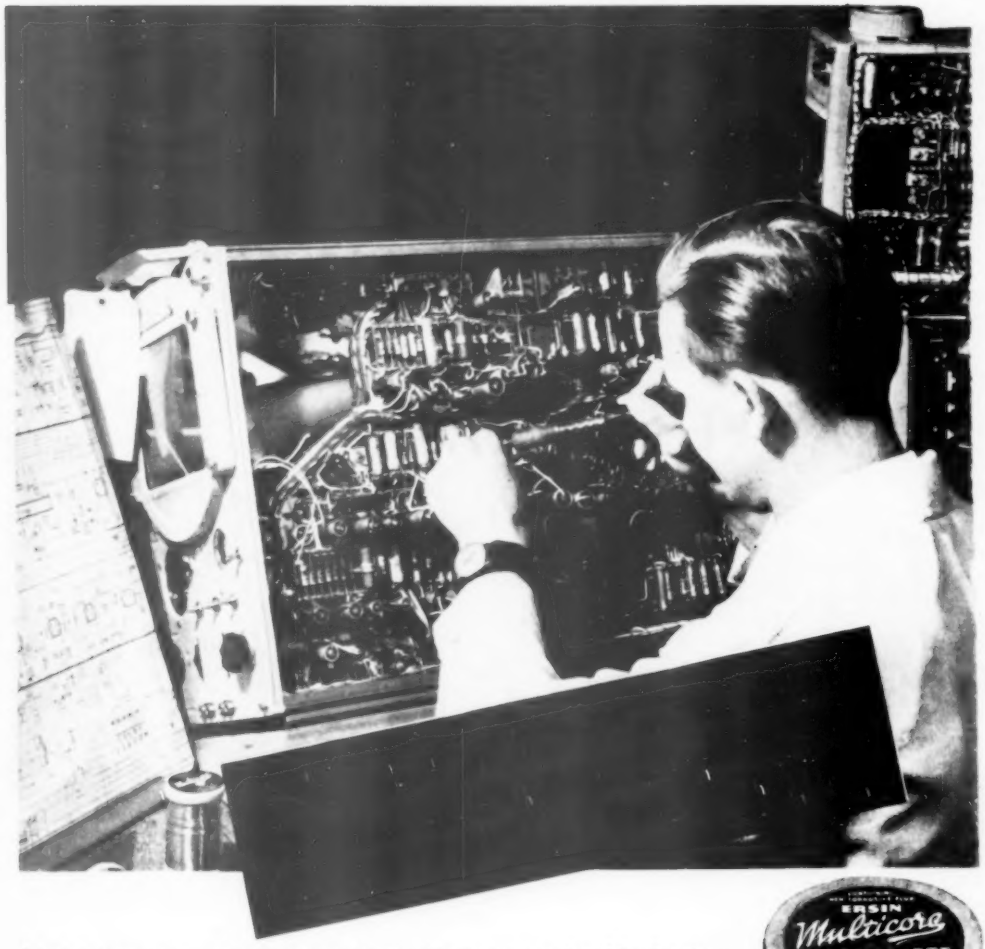

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